ASTM BULLETIN

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"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

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Forty-second Annual Meeting, Atlantic City, June 26 to 30, 1939

Several Interesting Technical Features Being Developed

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SEVERAL of the technical features in course of development for the Forty-second (1939) Annual Meeting of the Society to be held at Chalfonte-Haddon Hall, Atlantic City, from June 26 to 30, inclusive, will be of widespread interest to large groups of technologists in various industrial fields. These features which will take the form of symposiums or round-table discussions will be part of a well diversified program being developed by the Society's Committee E-6 on Papers and Publications. At its meeting in February, the committee reviewed the large number of offers of papers and a very strong technical program as a whole is in prospect.

Throughout the week of the annual meeting there will be in progress the Fifth Exhibit of Testing Apparatus and Related Equipment in which quite a number of leading manufacturers and distributors of testing and scientific instruments will participate and a number of the Society's committees and research institutions will sponsor special displays of interest in the engineering materials fields.

The decision to return to Atlantic City after the very successful meeting held in 1938 was influenced to a considerable extent by the World's Fair in New York City, plus the generally favorable reaction of many of the members to Atlantic City as a meeting place.

SYMPOSIUMS; ROUND TABLE DISCUSSIONS

A number of the major technical features are being held under the auspices of standing committees of the Society. This is true of the Round Table Discussion on Low-Temperature Application of Metals sponsored by the Joint A.S.T.M.-A.S.M.E. Research Committee on Effect of Temperature on the Properties of Metals; the Symposium on Paint Testing is being developed under the sponsorship of Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and the Session on Water, in the development of which Committee D-19 on Water for Industrial Uses is taking a leading part.

Another outstanding feature will be a Symposium on Shear Testing of Soils under the sponsorship of Committee D-18 on Soils for Engineering Purposes. As a result of discussion at the meeting of Committee E-2 on Spectrographic Analysis in Columbus, another topic involving quantitative spectrography will be developed, the committee having in mind a round table discussion comprising two or three sessions looking toward a more formal symposium in 1940.

The decision of the Joint Research Committee on Effect of Temperature to sponsor a round table discussion was based on the growing interest in this field and the importance of developing authoritative information and data on the properties and use of metals at low temperatures. F. B. Foley, Superintendent of Research, The Midvale Co., is head of the special committee in charge of this feature.

The Symposium on Paint Testing will make available information on latest theories and practices in evaluating various properties of paint and paint materials.

The series of papers forming the basis of the water session are expected to cover such topics as the electrical conductance measurement of natural waters and water extracts of textiles, determination of total solids, calculation of equilibria in dilute water solutions with applications to industrial water treatment, etc.

In the Symposium on Shear Testing of Soils, suggested topics include discussion of the shearing resistance of clay, the use of these tests in highway design, some practical aspects of soil shear testing, and others. Outstanding authori-

ties in this field in which there has been very rapidly growing interest will participate.

PAPERS AND REPORTS

In addition to the subjects mentioned above, there will be the usual number of interesting papers dealing with ferrous and non-ferrous metals; cement and concrete; masonry building units; and quite a number of contributions under the general heading of testing, including descriptions of apparatus, applications, etc.

Most of the standing committees are expected to have rather extensive reports in view of the large amount of standardization work which will be up for action at the meeting, including many new standards proposed for publication as tentative. A review of some of the accomplishments during A.S.T.M. Committee Week appearing in another portion of this BULLETIN will give some idea of the work which will be completed by some of the committees. A number will be presenting very extensive data resulting from the research work which has been under way, notably in the field of corrosion.

Following the procedure of previous years a Provisional Program for the meeting giving condensed synopses of technical papers, reports, etc., will be published in the May BULLETIN which will also contain further details of the meeting and the Fifth Exhibit of Testing Apparatus and Related Equipment.

HOTEL RESERVATIONS

Early in May there will be sent to each member a blank giving hotel rates at Chalfonte-Haddon Hall with a form which members can use in making reservations for the meeting. While it is expected the hotel management will make full provisions to take care of our members, the necessity of sending advance hotel reservations cannot be too highly stressed, especially this year. Members who wish can at any time send reservations to the hotel, explaining that they will be attending the A.S.T.M. meeting. These should be addressed to the hotel management, Chalfonte-Haddon Hall.

A number of members will be interested to know that Atlantic City is again having its annual Children's Week which will take place during the week of the A.S.T.M. meeting.

Doubtless those members who plan to stop at hotels in New York City during their visit to the Fair have realized the desirability of making hotel reservations early, but those who have not done so may wish to mention in their communications with certain hotels that they are members of A.S.T.M. The Waldorf-Astoria, Pennsylvania, and New Yorker will give cognizance to A.S.T.M. members as regular guests and will give such consideration as possible in connection with reservations. No concessions will be made as far as rates are concerned.

Fifth Exhibit of Testing Apparatus and Related Equipment

ALREADY the list of companies who will participate in the Fifth Exhibit of Testing Apparatus and Related Equipment, and other features which are developing, point to a most interesting and successful event during the course of the annual meeting in Atlantic City, June 26 to 30, inclusive. The Exhibit will be held on the Lounge Floor in the Vernon and Garden Rooms which are adjacent to the A.S.T.M. Registration Desk. This is the first time that an A.S.T.M. exhibit will have been held in Atlantic City, other exhibits having been in Chicago, Detroit, and the most recent and largest in New York in 1937.

From the very beginning the exhibits were planned by the Society officers to stress technical and educational phases, and that they have done so many have agreed. By and large, the exhibits have performed the desirable function of calling attention to wide ranges of equipment, new apparatus in development, and the like, through the close cooperation of manufacturers and distributors of equipment who have joined whole-heartedly in the general spirit pervading the exhibit.

At this year's exhibit there will be displays of all kinds of physical testing apparatus, tension, impact, fatigue, etc., instruments and apparatus in the optical fields, photomicrographic, spectrographic, colorimetric, etc. There will be new developments in the field of petroleum testing, pyrometry, laboratory glassware, speed indicating and recording instruments, calorimeters, instruments in the electrical fields, X-ray equipment and many other items.

The apparatus on display will, of course, include much equipment that is necessary in the performance of A.S.T.M. testing procedures, but there are hundreds of other instruments not covered by A.S.T.M. tests that are used in the field of engineering materials.

An advance list of companies in the industry who will participate includes the following:

American Instrument Co.
Baldwin-Southwark Corp.
Bausch & Lomb Optical Co.
Christian Becker, Inc.
Brabender Corp.
Central Scientific Co.
Eimer & Amend, Inc.
The Electric Tachometer Corp.
Henry A. Gardner Lab.
Kimble Glass Co.
Leeds & Northrup Co.
Metals and Alloys
National Carbon Co.
Nurnberg Thermometer Co., Inc.
Tinius Olsen Testing Machine Co.
Parr Instrument Co.
E. W. Pike & Co.
Radium Chemical Co., Inc.
Riehle Testing Machine Division, American Machine and Metals, Inc.
Rubicon Co.
George Scherr Co., Inc.
Henry L. Scott Co.
C. J. Tagliabue Manufacturing Co.
Westinghouse X-ray Co., Inc.
Carl Zeiss, Inc.

In addition to displays by the above organizations, several A.S.T.M. committees will participate. Displays by committees in the past exhibits have been most interesting and this year will be no exception. Further information will be given concerning these displays in the May BULLETIN. Of course, the surest way of seeing just what the Exhibit will contain is to plan to inspect it thoroughly.

Symposiums on Thermal Insulating Materials and on Lime at Regional Meeting

Three Sessions at Columbus

TWO extensive symposiums, one on thermal insulating materials, the second on lime, featured the 1939 Regional Meeting, held in Columbus, Ohio, on March 8, during A.S.T.M. Committee Week. The Society's Committees C-16 on Thermal Insulating Materials and C-7 on Lime, headed by J. H. Walker, The Detroit Edison Co., and Prof. J. R. Withrow, Ohio State University, respectively, sponsored the symposiums.

Quite a number of the members participated in the trip which had been arranged by the local committee to the plant of Owens-Corning Fiberglas Corporation in Newark. Luncheon was served, followed by visits which included the laboratories, insulation, wool, and textile manufacturing processes of this relatively new industry.

A number of the members also took advantage of their stay in Columbus to visit other points of interest, including the Battelle Memorial Institute which reported quite a number of A.S.T.M. visitors throughout the week.

General arrangements for the Columbus meetings were in the charge of a committee of A.S.T.M. members in the Columbus area, as follows:

C. E. MacQuigg (Chairman), Ohio State University.
W. W. Heimberger (Secretary), The Buckeye Steel Castings Co.
J. R. Withrow (Chairman, Program Committee—Symposium on Lime), Ohio State University.
O. E. Harder (Program Committee—Symposium on Thermal Insulating Materials), Battelle Memorial Institute.
R. C. Purdy (Chairman, Entertainment Committee), American Ceramic Society.
E. W. Campion (Chairman, Plant Inspection Committee), The Bonney-Floyd Co.
H. A. Depew (Chairman, Registration Committee), American Zinc Sales Co.
P. C. Hodges (Chairman, Publicity Committee), Marble Cliff Quarries Co.

The papers comprising the two symposiums, together with discussion, will be published in special volumes later in the year—further announcements will be made concerning them. Attention is called to the fact that those wishing to submit written discussion of any papers should send this to Society Headquarters before April 29.

SYMPOSIUM ON THERMAL INSULATING MATERIALS

The general purpose of the symposium was to point out important problems in the field of standardization and research which will need to be considered carefully by A.S.T.M. Committee C-16, and also to present latest thoughts and suggestions on various points. By stimulating discussion, viewpoints of different interests were brought out.

The technical papers comprising this symposium were as follows:

Factors Influencing the Thermal Conductivity of Non-Metallic Materials —J. B. Austin, United States Steel Corp. Research Laboratory.
A Discussion of Test Methods for Determining Physical Properties of Thermal Insulation—H. H. Rinehart, Johns-Manville Research Labs.
One Consumer's Problems in Selecting Heat Insulation—E. T. Cope and W. F. Kinney, The Detroit Edison Co.
The Effect of Solar Radiation on the Heat Transmission Through Walls —F. C. Houghten, Carl Gutberlet and Albert A. Rosenberg, American Society of Heating and Ventilating Engineers.

The paper by Mr. Austin gives a comprehensive survey and summary of fundamental problems in the physics of heat flow and the physics and chemistry of insulating materials. In discussing various factors he stated, in connection with chemical composition, that those compounds which have a simple molecular structure and which crystallize in a lattice of high symmetry, as for example, magnesia, which crystallizes in the isometric system, are better conductors than

Columbus Committee on Arrangements

Seated, left to right: H. A. Depew, E. E. Powers, C. F. Tefft, O. E. Harder, Clyde Williams, J. R. Withrow, J. O. Pence.
Standing, left to right: S. Stepanian, A. H. Durker, C. H. Johnston, G. N. Krouse, M. R. Hansen, C. E. MacQuigg, A. S. Watts, Lynn Bradner, G. A. Bole, D. J. Demorest, W. W. Heimberger.

more complex compounds such as forsterite (magnesium silicate). Among the simpler compounds, the best conductors are those whose component atoms have most nearly the same weight and the same electronic structure. Physical constitution has a larger influence on thermal conductivity than any other single variable. This is well illustrated by magnesia, which in the crystalline pore-free form is one of the best conductors among the refractory oxides, but in the form of powder ("precipitated magnesia") is one of the best refractory insulators. The effectiveness of the powder as an insulator is due to the presence of a film of air around each particle and is not a property of the magnesia itself; nevertheless, the difference in the conductivity of the two materials, which is of the order of a hundred fold, is a striking illustration of the influence of texture.

The paper by Mr. Rinehart outlined the viewpoint of the producer on various problems, while that by Messrs. Cope and Kinney reviewed the field from the viewpoint of the consumer. Both papers are considered to be of much value, since they outline important work which must be done, and both present essential information on projects which have been carried out involving both testing and inspection.

Mr. Rinehart concluded that it appears desirable to establish standard methods of test for thermal insulations covering the following, some of which apply to plastic insulations and some to preformed: (1) mixing procedure; (2) preparation of sample for tests; (3) dry molded density, expressed as such or as "dry coverage in board feet per 100 lb. of dry cement;" (4) temperature resistance. Thought and study are necessary both as to the desirability of standards and methods to be employed regarding the following: (1) consistency, (2) adhesion to steel, (3) cracking and curling, (4) absorption, (5) corrosiveness, (6) hardness, (7) flexural strength, (8) abrasion resistance, (9) toughness, (10) compressive strength, and (11) durability. It appears unnecessary to establish standards on the following properties: (1) loose density, (2) screen analysis, (3) shear strength, (4) tensile strength, (5) porosity, and (6) permeability.

Messrs. Cope and Kinney indicate that certain characteristics are more important than others. In the following list the more important are given first:

Preformed Material.—(1) Resistance to deterioration at working temperature; (2) resistance to breakage; (3) thermal conductivity; (4) ease of handling; (5) advantageous disposal of second-hand material.

Unformed Material.—(1) Resistance to deterioration at working temperature; (2) absence of caustic alkalinity; (3) trowel-ability; (4) air-drying shrinkage; (5) thermal conductivity.

They stated that finally, the writing of specifications and the agreement regarding test methods does not answer the problem with finality, nor does this standardization preclude the necessity for constant attention to other problems, such as the study of suitable methods of installation and the investigation of newly developed products which may show promise.

The fourth paper, representing a contribution from the American Society of Heating and Ventilating Engineers, emanated from the Research Laboratory of the A.S.H.V.E., prepared by the Director, F. C. Houghten, and two assistants, and presents unusual aspects of heat flow. The authors show that there may well be a variation in temperature head producing heat flow from the outside into the building, ranging from zero at night to from 60 to 80 F. some time during the day when the sun radiation is most effective. Under these conditions the assumption of steady state flow is so erroneous as to be absolutely useless to the designing engineer.

By means of a differential expression which has been developed and shown to apply, those concerned with problems of design can from a knowledge of the instantaneous inside wall surface temperature, the inside air temperature, and the steady state film conductance coefficient of the inside wall surface, determine instantaneous rates of heat flow through the inside wall surfaces.

The authors state that the results of the study point to the need of a considerably greater mass of data concerning the magnitudes of the expected changes in the surface temperatures and the rates of heat flow for a number of different types of walls and roofs, with different directions of exposure to sun radiation on days representing typical design conditions. Plans for such a study have been developed.

SYMPOSIUM ON LIME

As will be seen from the following list of papers, this symposium covered a number of fundamental aspects, certain research angles, and dealt especially with problems in the practical application of lime in its various forms. The papers were solicited largely through the efforts of the research subcommittee of A.S.T.M. Committee C-7 on Lime. Two sessions, morning and afternoon, were devoted to this technical feature.

Variations in Properties of Dolomitic Lime Putties with Method of Hydration—John E. Conley, U. S. Bureau of Mines, Nonmetals Division.

The Hydration of Magnesian Lime and the Autoclave Test—F. C. Welch, The Western Lime and Cement Co.

Manufacturing Lime for the Glass Industry—A. H. Nieman, The Ohio Hydrate and Supply Co.

Factors Affecting Milks of Lime Employed in Industry—D. E. Washburn, American Lime and Stone Co.

Quality of Lime Desired for Water Treatment—Charles P. Hoover, Columbus, Ohio, Water Works.

Prevention of After-Precipitation in Lime-Treated Industrial and Municipal Waters by Threshold Treatment—Owen Rice, Everett P. Partridge, and R. E. Hall, Hall Laboratories, Inc.

Soil Acidity and Liming, and Some Factors that Should Determine the Standards for Lime and for the Soil—E. O. Fippin, Tennessee Valley Authority.

Criteria for the Evaluation of Agricultural Ground Limestone—R. M. Salter, Ohio State University, and C. J. Schollenberger, Ohio Agricultural Experiment Station.

Preliminary Investigation of the Determination of Fluorine in Lime—C. J. Kochler, National Gypsum Co.

Fundamental Mechanics of Calcination and Hydration of Lime and Methods of Control—Victor J. Azbe, Consulting Engineer, St. Louis, Mo.

Lime Characteristics and Their Effect on Construction—Walter C. Voss, Massachusetts Institute of Technology.

In the summary and conclusions of his paper, "Variations in the Properties of Dolomitic Lime Putties with Method of Hydration," Mr. Conley points out that: (1) the properties are affected by calcination history and by hydration conditions; (2) hydration with an excess of water produces a more plastic hydrate and a putty of greater volume than when the lime is hydrated with the theoretical water to yield a dry hydrate; (3) control of calcination conditions to produce an active form of magnesia and subsequent temperature control to insure complete hydration of the mag-

nesia are desirable to produce a superior hydrate of high plasticity and high putty volumes for use as finishing plaster; (4) generally, those hydrates that yield high putty volumes are slow settling.

In covering the "Quality of Lime Desired for Water Treatment," Mr. Hoover summarized his opinions as follows: When considering lime specifications, the principal factors which determine the usability of lime for water treatment are the percentage of available calcium oxide and the slaking properties; determinations of other ingredients are unnecessary. The percentage of water-soluble oxide to be specified and the type of lime to be used can best be determined by giving consideration to quantity of lime required, location of lime-producing plants, storage facilities at the water-treatment plant, and type of equipment available for applying the lime to the water under treatment.

In the conclusions to his paper on "Soil Acidity and Liming," Mr. Fippin pointed out that the scientific understanding of the functions of lime in soil fertility and crop growth is growing at a rapid rate. The complexity and interdependence of the problems of soil acidity, fertilizer need, and the methods for their correction are well indicated by the statement of Willis (112) that, "A new perspective of research is clearly indicated by the evidence that phosphorus, potassium, copper, manganese, boron, silica dioxide, organic matter, hydrogen-ion concentration, aeration and temperature are in some degree dependent variables." Intimate cooperation of the scientist, the teacher, lime producers and distributors, and farmers, should continue, as the best means to find solutions of the problems presented.

The American Society for Testing Materials, the agricultural research and regulatory agencies, and the producers and handlers of lime, all of whom are concerned with definitions and standards in liming materials for the soil, and in the maximum guidance of farmers in the use of such materials, well may consider how far they may need to move toward more simple, accurate, and adequate standards in respect to terminology and official methods of comparing materials. If liming practice follows the trend of fertilizer practice, the element basis or equivalent calcium basis of comparing and reporting materials will be increasingly employed as liming materials are more scientifically used to perform the diverse functions of which they are capable in the soil.

In their paper, "Criteria for the Evaluation of Agricultural Ground Limestone," the authors, R. M. Salter and C. J. Schollenberger, show that the size composition of commercial ground limestone can be plotted as a straight line, and the relative efficiency of the several size grades on the market predicted therefrom with practical accuracy.

From theoretical considerations, supplemented by experiments with uniform weights of a number of 48 and 65-mesh limestones and soil kept under conditions intended to simulate those in the field, a relation between chemical composition and dissolution in soil has been worked out. This is expressed by the equation

$$R = \frac{\%\text{ of calcite, impurity-free}}{1.64} + \frac{\%\text{ of dolomite, impurity-free}}{1.205}$$

in which R is the per cent added carbonate residual at the end, and the denominators are dissolution constants applying, respectively, to calcite and dolomite. These constants will vary with particle size, time, and other experimental conditions, but for practical comparisons of the probable value of limestones differing only in chemical composition and with other conditions similar, the average values given should serve. The percentages of carbonate minerals calculated from analysis are reduced to the impurity-free basis by the factor

$$\frac{100}{100 - \text{percentage of impurities}}$$

The percentage decomposition is then $100 - R$, but requires a correction for the deficiency in application due to the content of impurities, or

$$(100 - R)\left(\frac{100}{100 - \text{percentage of impurities}}\right) = \text{corrected percentage decomposition.}$$

Considering the uncertainty as to the status of impurities in a commercial ground limestone, that is, as to whether such impurities were an intimate constituent of the original rock, or were segregations of gangue, etc., ground with it or perhaps even of extraneous origin, the agreement between observation and calculation appears to be quite good.

In his paper "Fundamental Mechanics of Calcination and Hydration of Lime and Methods of Control," Mr. Azbe emphasizes certain factors: First, lime—and particularly some lime—should be burned at lower temperatures; second, most lime on the market is overburned; third, much can be done by merely reducing the size of stone and increasing the frequency of draw and through arrangement for better trimming facilities; and fourth, to accomplish the most, however, temperatures must be controlled by means of recirculation of hot gases. While by lowering the temperatures, heat transfer is lowered, that is made up by increasing the heat absorbing surface, increasing the rate of flow of the gases, raising the burning zone, obtaining more uniform cross-sectional flow and elimination to a great extent of blocking by fines and by retaining the lime in a state permitting ready liberation of CO_2 without excessive internal CO_2 and the consequent greater external temperatures necessary.

The paper dealing with "Lime Characteristics and Their Effect on Construction" included considerable information and data developed by the author, Professor Voss. Among the various points listed in his summary are the following: (1) that 45 lb. is a rational average value for 1 cu. ft. of lime solids; (2) apparent yields of putties are misleading and tend toward oversanding—lime putties should be used on a "lime-solids" basis; (3) that waterproofed limes produce putty light in weight and therefore give a fictitious yield and a more porous structure.

Discussion of Lime and Thermal Insulating Symposiums

MEMBERS of the Society and others who wish to submit written discussion of the papers comprising the Symposiums on Lime and Thermal Insulating Materials (see page 3), held as the technical features of the Columbus Regional Meeting of the Society, are requested to submit copies of their discussion in duplicate as soon as possible. Committee E-6 on Papers and Publications has set April 29 as the closing date. It is expected that these two symposiums will be issued in the next few months in the form of special publications including the papers and discussion. Further announcement concerning them will be made.

Numerous Actions Recommended at Committee Week in Columbus

Many New Standards Proposed; Research Work Active

SINCE 1939 is the year when the combined Book of Standards and Tentative Standards will be issued (thereafter triennially) practically all committees have concentrated on bringing various specifications and tests up to date, recommending the adoption of revisions which have been published previously, taking action to adopt as standard existing tentative specifications and at the same time recommending new specifications covering many materials not now included. The meetings of numerous committees during A.S.T.M. Committee Week in Columbus were therefore quite significant.

There were 149 such meetings with registered attendance of 570 for the week. Since a number of large committees did not participate, having held meetings previously or holding them in the very near future (for example, D-2 on Petroleum Products and Lubricants, D-9 on Electrical Insulating Materials and D-20 on Plastics were holding sessions during the week of March 13 in Washington, D. C.), this attendance is considered excellent.

A list of the committees which met in Columbus follows. In most cases a number of subcommittee meetings and sections were also held in connection with the main committee meetings:

A-1 on Steel
A-2 on Wrought Iron
A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-7 on Malleable Iron Castings
A-10 on Iron-Chromium-Nickel Alloys
B-2 Sub. III on White Metal Alloys
B-3 on Corrosion of Non-Ferrous Metals
B-5 on Copper and Copper Alloys
B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys
C-1 on Cement
C-7 on Lime
C-8 on Refractories
C-9 on Concrete and Concrete Aggregates
C-12 on Mortars for Unit Masonry
C-15 on Manufactured Masonry Units
C-16 on Thermal Insulating Materials (Sub. II, III, IV, V, and VI only)
D-3 Sub. III on Determination of Calorific Value of Gaseous Fuels and Sub. V on Determination of Impurities of Gaseous Fuels
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-6 Sub. IV on Fiberboard Containers
D-8 on Bituminous Waterproofing Materials
D-11 on Rubber Products
D-18 on Soils for Engineering Purposes
E-1 Section on Tension Testing; Section on Effect of Speed of Testing; Technical Committee XI on Designation and Interpretation of Numerical Requirements
E-2 on Spectrographic Analysis
E-4 on Metallography
Research Committee on Fatigue of Metals
Joint Committee on Exposure Tests of Plating on the Non-Ferrous Metals

The outlines given below of various committee activities will give some idea of the progress made and of the programs which the committees have under way. *Most of the actions taken at the meetings will, of course, be submitted to letter ballot prior to formal recommendation to the Society,* this being particularly true in the case of actions in the standardization field. It will be noted that many new standards are being considered for recommendation to the Society for publication as tentative and that a number of existing tentative specifications and tests will be offered for formal adoption as A.S.T.M. standards.

Committee A-1 on Steel

A further effort will be made to consolidate specifications covering mild steel plates (A 10) and steel plates for forge welding (A 78), a report being expected at the June meeting. The need for standardized requirements for structural bolt steel resulted in the decision to appoint a section to draft a recommended standard. There was extended discussion on the possibility of consolidating the specifications for steel for bridges (A 7) and for buildings (A 9) and finally it was decided to study this matter further before taking any action.

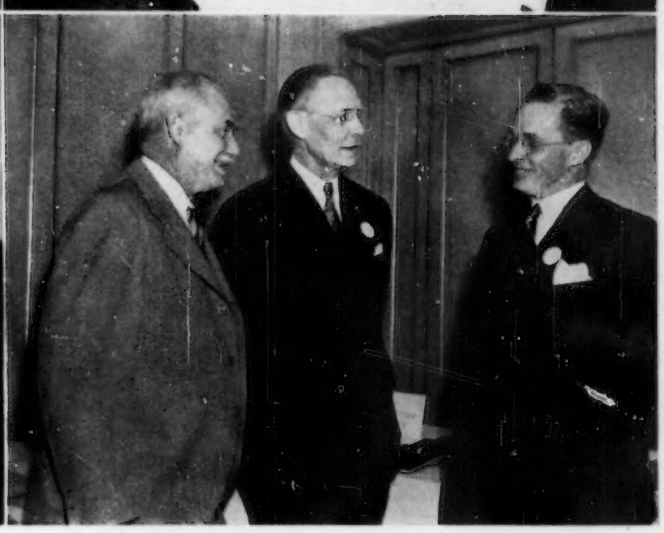
Concentrated work in recent weeks resulted in recommendations to approve quite a number of editorial changes and some substance changes in the four specifications covering various types of steel springs, elliptical and helical. Titles and scope clauses of certain of the specifications will be changed to indicate a broader application and other modifications will be detailed in the 1939 A-1 report. Likewise, changes were proposed in the five specifications covering various types of spring bar steel, the tables of permissible variations being brought up to date, one specification covering carbon-steel bars for general purpose springs (A 58) to be studied for the June meeting concerning whether it should be revised more extensively or withdrawn. The possibility will be considered also of combining this specification with those covering carbon-steel bars (A 14) and carbon-steel bars with special silicon requirements (A 68).

The two main objectives of Subcommittee VI on Forgings, namely, to consolidate existing requirements for carbon-steel and alloy-steel forgings in two specifications were the chief problems discussed. The section on carbon-steel forgings reported substantial consensus on a proposed specification providing for seven classes of forgings. This new specification will replace carbon-steel requirements in the three existing specifications A 18, A 19 and A 20, and brings up to date certain of the requirements. The tensile strength of the various grades ranges from 47,000 to 90,000 psi. with yield point of 25,000 to 55,000 psi.

The work on combined specifications covering alloy-steel forgings resulted in the inclusion of major points in a draft to be submitted to the subcommittee for consideration and comment, the expectation being that requirements can be issued as a new specification by action at the June meeting.

The adoption as standard of the specifications covering carbon-steel castings for miscellaneous industrial uses (A 27) was recommended. Another important action was the approval for submission to letter ballot of new specifications for carbon-steel castings for miscellaneous industrial uses

(*Continued on page 9*)



Top Right: B. J. Barmack (right), Commonwealth Edison Co., presiding at a meeting of the Section on Galvanized Strand of Committee A-5; C. E. Ambelang, Public Service Co. of Northern Illinois, is acting secretary. In this group **(Top Left)** are: (left to right) Front Row: J. J. Maher, Page Steel and Wire Co.; W. F. Markley, Western Union; Second Row: T. R. Galloway, Consolidated Edison Co. of New York; L. H. Winkler, Bethlehem Steel Co.; J. L. Gregg, Bethlehem Steel Co.; Third Row: G. E. Baumgardner, Norfolk & Western Railway Co.; R. J. McCabe, Indiana Steel and Wire Co.; F. C. Elder, American Steel & Wire Co.; F. M. Crapo, Indiana Steel & Wire Co. **Lower Left:** C. T. Edgerton (right), Crucible Steel Co. of America, chairman of the Steel Committee's Subcommittee IV on Spring Steel and Steel Springs, with T. R. Weber (left), American Locomotive Co., chairman of the section studying the spring and bar specifications. **Lower Right:** Oscar E. Harder (left), Battelle Memorial Institute, Acting Chairman of the Columbus Committee on Arrangements, and A.S.T.M. Vice-Presidents William M. Barr (center), Union Pacific Railroad Co., and H. H. Morgan (right), Robert W. Hunt Co.

1939 Committee Week, Columbus, Ohio

(Five large photographs—courtesy of the Columbus *Citizen*)

Bottom (left): Meeting of Section on Alloy Steel Forgings of Committee A-1 (clockwise, starting lower left)—E. J. Edwards, American Locomotive Co.; J. H. Higgins (*chairman*), Camden Forge Co.; O. B. Schultz, Lima Locomotive Works, Inc.; A. O. Schaefer, The Midvale Co.; G. L. Norris, Vanadium Corp. of America; R. W. Steigerwalt, Carnegie-Illinois Steel Corp.; P. E. McKinney (back to camera), Bethlehem Steel Co., Inc.; E. N. Downing (upper), General Electric Co.; D. R. Carse (extreme right), Climax Molybdenum Co.

Bottom (left to right): Past-President A. E. White, University of Michigan; and Assistant Secretary R. E. Hess; Prof. H. F. Moore, University of Illinois; F. G. Tatnall, Baldwin-Southwark Corp.; R. L. Templin, Aluminum Co. of America.

1939 A.S.T.M. Photographic Exhibit

DEFINITE plans have been developed for the Second Annual Photographic Competition and Exhibit to be sponsored by the Society and held during the Forty-Second Annual Meeting in Chalfonte-Haddon Hall, Atlantic City, June 26 to 30, inclusive.

A meeting of the committee in charge of the exhibit was held recently at A.S.T.M. Headquarters, the personnel of the committee being as follows: J. P. Eldridge, *Chairman,* Leeds & Northrup Co.; E. L. Hettinger, Wilson Products, Inc.; J. H. Higgins, Camden Forge Co.; Bruce Lewis, E. J. McAleer & Co.; R. P. Loveland, Research Laboratories, Eastman Kodak Co., representing Committee E-4 on Metallography; and J. P. Mudd, The Midvale Co.

"Testing and Research in Engineering Materials" is to be the subject or general theme of the exhibit. In addition to photographs of apparatus, instruments, testing and related items, also eligible will be photographs showing unique or unusual applications of materials. It is to be divided into, first, a General Section and, second, a Section on Photomicrography. The latter will be developed under the auspices of Committee E-4 on Metallography which has sponsored displays in the two last exhibits of testing apparatus and related equipment. Mr. Loveland has been appointed to the photographic committee to supervise the section on photomicrography for Committee E-4.

The photographs in the General Section will be judged for first, second, and third place and an honorable mention, judging to be based on the following:

70 per cent—Portrayal Value, that is, how well the photograph tells its story. This will include photographic technique and artistic value.

30 per cent—Timely Interest and Importance of Subject Matter. For this part of the rating, the judges may call upon various A.S.T.M. members, more or less specialized in their line, for assistance.

The committee has set up simple rules which apply primarily to the General Section. These are as follows:

All photographs are to be mounted on 16 by 20 in. white or buff mounts and accompanied by a typewritten description or title of not more than fifteen words. Transparencies are welcomed but can be exhibited only if accompanied by an illuminating device.

Both amateur and professional photographs are solicited, but the awards will be confined to the amateur class. "Amateur" will be construed as applying to any photograph made by an A.S.T.M. member or an employee of a member company whose principal occupation is not photography. Either the negative or print should be made by the amateur.

The committee reserves the right to reject any pictures submitted and is not responsible for loss or damage to prints.

It is understood that permission to reproduce photographs in the ASTM BULLETIN is automatically granted when the pictures are submitted.

Entry blanks must be received by June 1 and prints must be received by June 15. All prints should be sent to J. P. Eldridge, Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia, Pa., in containers suitable for return mailing. Return shipping labels should accompany each container.

SECTION ON PHOTOMICROGRAPHY

For the Section on Photomicrography all prints should be mounted on 16 by 20 in. white or buff mounts and should be accompanied by a typewritten description or title. Transparencies are invited, it being the stipulation as in the General Section that illuminating boxes be provided by the exhibitor. There will be no distinction in the photomicrography section between amateur and professional entries since Committee E-4 wishes to have an educational display with as wide a range as possible.

The Section on Photomicrography is not limited to the field of metallography. This section is open to all studies in this field broadly, pertaining to work on metals, petrography, fineness, etc.

The basis of awards and general methods of judging will be established by Mr. Loveland in cooperation with the officers of Committee E-4. All photomicrographs should be shipped to Mr. Eldridge who will be in close touch with Mr. Loveland to take care of necessary details.

The accompanying blank can be used in submitting entries for either the general or photomicrography section. A blank will be also printed in separate form and copies can be obtained on request from A.S.T.M. Headquarters.

1939 A.S.T.M. PHOTOGRAPHIC EXHIBIT ENTRY FORM

MR. J. P. ELDRIDGE, *Chairman, Photographic Exhibit*
LEEDS & NORTHRUP CO.
4901 Stenton Ave., Philadelphia, Pa.

Dear Sir:

The following prints are to be submitted: ☐ General Section; ☐ Photomicrographic

	Title or Description (15 word Maximum)
1	
2	
3	
4	

Name .....
(Print Clearly or Type)

Company .....

Address .....

Committee Week

Activities Summarized

(*Continued from page 6*)

suitable for fusion welding. The eight grades of material covered have a maximum carbon of 0.25 or 0.35 per cent with the top manganese at 0.70, but with a special provision for an increase in manganese for a reduction below the maximum carbon content. Tensile strengths range from 60,000 to 70,000 psi.; yield point from 30,000 to 38,000 psi. There has been considerable demand from various interests for standardized requirements for this material and it is felt the new specification when approved will be of definite service.

Possibly the most interesting of the items in the field of pipe and tubing was the approval subject to ballot of new specifications covering alloy-steel boiler and super-heater tubes. Thirteen grades of material are set up, nine of which are ferritic and four austenitic types, the minimum tensile strength for the ferritic, 60,000 psi.; for the austenitic, 75,000 psi., with respective yield points of 25,000 and 30,000 psi. Action was taken also to recommend new specifications for electric-resistance welded heat-exchanger and condenser tubes; electric-resistance-welded steel boiler tubes for high-pressure service are expected to be covered shortly in another new specification.

A proposed combination of the specifications covering carbon-silicon steel plates (A 149) and (A 150) was approved, two grades being set up: one, requiring a tensile strength of 65,000 to 77,000 psi.; the other, 70,000 to 82,000 psi. This specification covers material up to $4\frac{1}{2}$ in. in thickness but not exceeding 25,000 lb. theoretical weight for plates of over $4\frac{1}{4}$ to $4\frac{1}{2}$ in. inclusive in thickness.

The committee plans to meet a demand for requirements for a higher strength boiler rivet steel than the present one covered in the specifications (A 31), namely, a 45,000 to 55,000 psi. grade, by incorporating a second grade with a 58,000 to 68,000 psi. tensile range. It was felt the objective could be met by incorporating the new grade in the existing specifications rather than to issue a separate document.

At the request of Subcommittee XIII on Methods of Physical Testing consideration had been given by various other specification-writing groups to the requirements which should be incorporated on speed of testing. In view of some differences of opinion, particularly on the limiting speeds from the yield point to the ultimate strength, and the necessity of getting more detailed information on speeds now in effect in the various steel products fields this subcommittee plans to send a questionnaire to elicit these data which will then be studied before final recommendations are made.

Committee A-2 on Wrought Iron

This committee reported minor changes in the requirements for welded wrought-iron pipe (A 72) and also acted to have adopted the revision requiring pipe to be made from "all pig puddled or processed" wrought iron.

The elongation requirements of the single and double refined bar specifications (A 189) are to be brought in line with those for common iron bars (A 85) and rolled or forged blooms (A 73) and the specification will cover material up to a total cross-sectional area of 12 sq. in.

The following tentative specifications are recommended for adoption as standard: plates (A 42); rolled shapes and bars (A 207); uncoated sheets (A 162), and zinc-coated sheets (A 163).

An editorial change stating that the material "shall be piled, forged and rolled twice" is to be made in the requirements for forgings and blooms (A 73).

Existing revisions are to be adopted in the chain specifications (A 56), including revised proof test loads which are to be 38 per cent of the breaking load.

Committee A-3 on Cast Iron

The subcommittee on car wheels presented a progress report and the group concerned with chilled iron announced that it was conducting an investigation of tension test specimens. The subgroup in charge of work on impact testing plans to submit shortly for study and comment a drawing of a proposed impact testing machine.

The newly formed subcommittee on soil pipe plans to modify the A.S.T.M. specifications for this material to bring them in line with requirements set up by certain committees functioning under the sponsorship of the American Standards Assn.

There was discussion of the work on pressure pipe, a subcommittee on this material being in the course of organization. Action was taken to carry on the investigation of overstressing of cast iron with irons in the 20,000 and 50,000 psi. classes. Professor Kommers, University of Wisconsin, has done similar work on a 35,000 psi. class iron.

Committee A-5 on Corrosion of Iron and Steel

Committee A-5 has under way several very extensive series of outdoor exposure tests, including those of black iron and steel sheets at Annapolis, these having been under way continuously for over twenty-two years. Additional failures of the sheets are being recorded. Likewise, tests on galvanized sheets, coated hardware and structural shapes, etc., are being inspected regularly at the various test sites.

In the total immersion tests all but two of the specimens have failed and the committee expects this research to be completed within the coming year, at which time a final report on the tests will be made.

One of the important subjects discussed was the first report of the committee in charge of inspection of the wire tests. This work is under the direction of C. D. Hocker, Plant Materials Engineer, Bell Telephone Laboratories, Inc. These extensive tests involving many miles and thousands of specimens of farm-field fencing, barbed wire, unfabricated wire, wire strand, and chain-link fence, with test locations at eleven points from coast to coast, have as their primary purpose determination of the effect of such factors as base-metal composition, gage, type of coating, weight of coating, etc., on the serviceability of zinc-coated strand, barbed, and woven wire fencing and unfabricated wire.

Mr. Hocker reported that about 17 per cent of the bare wire material has been brought in from the test sites for the physical tests to determine loss in strength. Of the coated samples, two per cent have been brought in and subjected to tension tests. Very extensive tables were prepared reporting the data resulting from these tests. These are to be studied and published in the 1939 report of Committee A-5.

The material has been on exposure for about two and a quarter years, practically all of the test stations having been erected in the period November 15 to December 26, 1936.

It was announced that the results of the referee tests of the materials in this program would also be published in the 1939 report. These will include complete data on the original materials exposed. The work was done at the National Bureau of Standards, Washington, D. C., by two research associates employed by Committee A-5.

Revisions will be recommended in several existing specifications providing requirements for protective coatings on wire and wire products. A general review of other specifications sponsored by the committee has been made, three of which covering electrodeposited coatings on steel are to be revised this year, prescribed methods of taking samples to be included. Proposed methods for determining thickness of electrodeposited coatings are to be recommended during the year.

An important action taken will be the removal of the sections on the Preece test from the method of testing weight and uniformity of coating (A 90), the method in the future to cover only tests for determining weight of coatings. A general method for conducting the Preece test for uniformity of coating is being prepared. This will include procedures given in the existing methods A 191 and A 208 covering uniformity of coating by the Preece test on zinc-coated iron or steel wire and on steel castings, forgings and related shapes. It will also include a procedure for determining uniformity of coating of bolts, nuts and similar zinc-coated articles.

Committee A-7 on Malleable-Iron Castings

Action was taken to recommend the adoption as standard of the tentative specifications for cupola malleable iron (A 197). These call for a minimum tensile strength of 40,000 psi.; minimum yield point of 30,000 psi. and elongation in 2 in. of 5 per cent.

Since no suggestions had been received of changes desirable in the standard requirements for castings made by the air-furnace, open-hearth or electric-furnace process (A 47) these are to stand unaltered.

Proposed specifications for pearlitic malleable iron were discussed and then approved for a letter ballot vote.

There was considerable interest expressed in the work of Subcommittee VII on Welding—it was decided to prepare a report on this subject for consideration at the meeting in June at Atlantic City.

Committee A-10 on Iron-Chromium-Nickel and Related Alloys

As a result of consideration at its meeting, Committee A-10 plans to present a guide or recommended practice for corrosion testing in plant equipment. After review by other interested committees of the Society it is expected the guide will be submitted for publication.

A special subgroup has examined installations of plain chromium and chromium-nickel steel used for architectural purposes in New York City, Philadelphia, and Atlantic City, to determine the conditions of the material after exposure to industrial and sea coast atmosphere. A report is in preparation giving the results of the inspection and including chemical composition of the materials, method of fabrication, etc. This information will be included in the 1939 Report of Committee A-10.

Another important phase of the committee's work will be covered in its report, namely, the work of Subcommittee VI on Metallography involving a study of intergranular precipitation in 18 per cent chromium, 8 per cent nickel corrosion-resisting steels. Principally, the report will show the effects of various reagents and indicate those which seem most satisfactory for the detection of intergranular material.

It is proposed to adopt as standard the tentative specifications for corrosion-resisting chromium-nickel steels (sheet, strip and plate) (A 167) and Subcommittee X recommended similar action on eight existing specifications for various types of chromium-nickel alloy steel castings. These include all of the casting specifications prepared by this group except the one for 12 to 14 per cent chromium. This is being held as tentative pending consideration of adding another grade.

A paper detailing studies of test blocks for corrosion-resistant steel castings developed by the Alloy Castings Research Institute is contemplated for presentation at the annual meeting in June in Atlantic City.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys

Accomplishments at the meeting of this committee include a proposed standardized method of salt-spray corrosion testing for non-ferrous metals and alloys and the development of a cooperative series of accelerated laboratory tests using the total immersion procedure in both aerated and non-aerated solutions. Corrosion data to be published in the 1939 B-3 annual report were reviewed and it was indicated that this would be of outstanding interest.

In the cooperative accelerated laboratory test project, four different laboratories will carry out series of tests with the proposed method using six different kinds of metals in each of three different solutions (sodium chloride, sodium hydroxide and sulfuric acid). The committee anticipates that the results of these tests, with a detailed description of the test procedure used and an evaluation of the immersion tests as applied to non-ferrous metals, should be available for the 1940 report.

The subcommittee on salt-spray testing has prepared a proposed tentative procedure which describes the apparatus and details the methods to be followed but does *not* specify the requirements which should be met by any product.

Subcommittee VIII on Galvanic and Electrolytic Corrosion is completing its study and tests on samples which have been exposed for seven years. Some 20 different metal combinations have been on exposure at nine different test locations. The report this year will include the results of inspection of these metal combinations at each test location after one year, three year, and seven year periods of exposure and will draw such conclusions as seem warranted by the data. This same committee will also present results of preliminary tests carried out on combinations of six different metals immersed in sea water.

Subcommittee VIII plans to arrange a display of specimens and other exhibits during the 1939 ASTM Annual Meeting in Atlantic City.

A new subcommittee has been organized for the purpose of developing specifications. The first work of this group

(*Continued on page* 37)

Development of a Method of Classifying Paints According to Gloss[1]

By Richard S. Hunter[2] and Deane B. Judd[2]

THIS paper has been prepared as the result of cooperation between the National Bureau of Standards and Subcommittee XVIII on Physical Properties of Materials of the Society's Committee D-1 on Paint, Varnish, Lacquer, and Related Products. A previous paper, entitled Methods of Determining Gloss (2)[3], was presented before the Society in 1936. It dealt with materials of all kinds and described various types of gloss and various methods of gloss measurement.

The present paper deals with paints and the development of a method of measurement which may be used to classify paints according to gloss. High gloss, eggshell, flat, semigloss, and satin finish are well-known terms for describing glossiness of painted surfaces. Though no quantitative definitions of these terms have been adopted, paint manufacturers have so controlled their products that the greater number of paints marketed under any one of the commonly used gloss terms have had about the same glossiness. As might be expected, however, there have been exceptions to this general tendency; so the purchaser of paint has never been sure that the finish wanted would be obtained when he used one of the above gloss-descriptive terms as a specification. Neither has the dealer been sure that the paint which he supplied would have the glossiness wanted.

In the near future it is hoped that Committee D-1 will promulgate a method of classifying paints according to gloss and thus define quantitatively several gloss terms. Work on the development of such a method is reported in the present paper and the draft of a tentative standard method is given. It is hoped that this suggested tentative method may be adopted.

For developing this method of classifying paints according to gloss, three painted plaques representative of "high gloss," "eggshell," and "flat," respectively, were collected from each of eight paint manufacturers. The data reported in the present paper are results of tests of these 24 specimens. The choice of methods of measurement, and selection of limits between the different classes of gloss, have been based on the measurements of these plaques.

The method of measurement and classification of gloss reported here gives results which accord fairly well with the usage of the paint industry. It would be unsafe, however, to extend the method and classification to other types of surfaces without first proving their applicability.

METHODS OF DETERMINING GLOSS

To make clear the scope and limitations of the method of gloss measurement and classification proposed, parts of the previous paper on methods of determining gloss (2) are summarized here.

Three fundamental terms used in this discussion are gloss, glossiness and apparent reflectance. They are defined as follows:

1. *Gloss* is the property of a surface by which it reflects light specularly.

2. *Glossiness* of a surface is the appearance ascribable to its gloss.

3. *Apparent reflectance* of a sample is the reflectance which a perfectly diffusing surface would require in order to yield the same brightness as the sample under the same conditions of illumination and viewing (2, 4).

To study the reflective properties of materials, apparent reflectance is measured as a function of angles of incidence and view. In studies of gloss, interest is centered on apparent reflectance in specular and near specular directions because the phenomenon of gloss is associated with specular reflection. It has been customary to consider the light reflected by a surface illuminated unidirectionally to be composed of two parts: a diffuse-reflectance component D, following Lambert's law; and a superposed specular component, S, — as illustrated in Fig. 1. The diffuse-reflectance component, D, is drawn according to the cosine law; that is, the surface is assumed to appear equally bright from all directions except those centered about the direction of specular reflection. The superposed specular-reflectance component, S, is associated with the glossiness of the surface. When this component is distributed through a range of directions centered on the direction of specular reflection, as in Fig. 1, an observer rates the surface either semigloss or mat, depending on the angular width of the specular component. When, on the other hand, it is concentrated closely about the angle of specular reflection, an observer rates the surface as glossy or mirror-like.

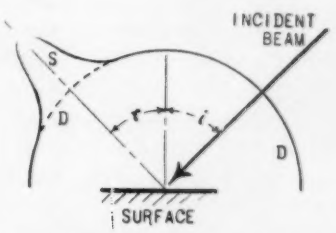


Fig. 1—Distribution for Unidirectional Illumination of Light Reflected by a Surface which, for Non-specular Directions of Reflection, Obeys Lambert's Law.

Circle D = diffuse component, Curve S = superposed specular component.

A goniophotometer will measure apparent reflectance as a function of directions of illumination and view. In the photoelectric adaptation of the McNicholas goniophotometer (5, 2) used at the National Bureau of Standards (see Fig. 2)

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to Society Headquarters.

[1] Report to A.S.T.M. Committee D-1 on Paint, Varnish, Lacquer and Related Products at the Forty-first Annual Meeting, Atlantic City, N. J., June 30, 1938.

[2] Junior Physicist and Physicist, respectively, National Bureau of Standards, Washington, D. C.

[3] The numbers in parentheses refer to the reports and papers appearing in the list of references appended to this paper, see p. 18.

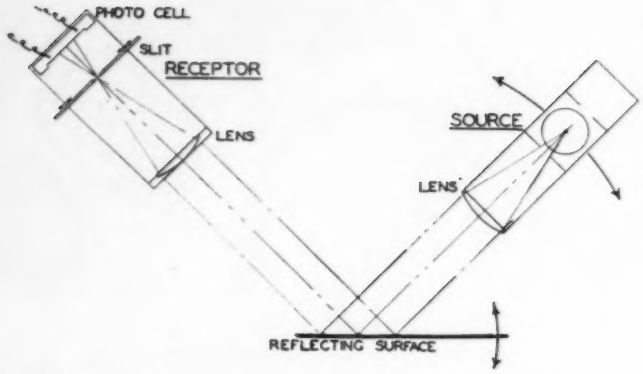


Fig. 2—Photoelectric Modification of McNicholas Goniophotometer.

(Reproduced from earlier paper (2), Fig. 3, p. 26.)

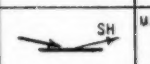
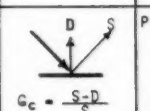
the source and surface may be rotated about an axis in the sample plane passing through the point of incidence of the center of the incident beam and perpendicular to it.

Actual samples, measured on a goniophotometer, give, however, apparent reflectance curves such as *P* and *M* in Fig. 3 rather than as in Fig. 1. Curve *P* gives the apparent reflectance of a plaque of white vitreous enamel on metal. One could say in this case that the nearly constant apparent reflectance represented the diffuse component and the extension of the curve in the direction of specular reflection represented the specular component. On the other hand, curve *M*, obtained from a sheet of white mimeograph paper, does not lend itself to separation into two such components. There is in the form of this curve no suggestion that the light reflected from this sample might be resolved into diffuse and specular components; it shows that separation into specular and diffuse components is not always possible.

The complete goniophotometric specification of a reflecting surface requires that, for each direction of illumination, apparent reflectances be given for different azimuthal angles of the hemisphere as well as for different angles in the plane of incidence. The use of different azimuths is important for surfaces exhibiting structural regularities such as brush marks. A surface not exhibiting structural regularities (such as one painted by spraying), which may be rotated in its own plane without changing its apparent reflectance, may be specified by measurements in the plane of incidence only. Because of the time required to obtain them, even the measurements needed to give an adequate specification in the plane of incidence only are seldom attempted. Assuming that the apparent reflectance of such samples for each direction of illumination can be adequately specified by 20 points, a family of 10 curves requiring 20 points each would be necessary for each surface examined; such measurements would of course prove burdensome.

Because of the amount of work, complete analyses of the gloss of surfaces are seldom attempted. However, profitable use has been made of goniophotometric curves like those in Fig. 3 which apply to single directions of illumination and planes of view (2, 4, 7). (See also Fig. 6 of the present paper.)

TABLE I.—TABULATION OF SIX TYPES OF GLOSS ACCORDING TO APPEARANCE, METHOD OF MEASUREMENT, AND CLASSES OF SURFACES.

TYPE OF GLOSS	GLOSSINESS (APPEARANCE) CORRELATES	DIAGRAMMATIC REPRESENTATION	CLASSES OF SURFACES INVOLVED	GLOSS RANGE INVOLVED
SPECULAR GLOSS	SHININESS, BRILLIANCE OF HIGH LIGHTS		PAINTS, SURFACES OF MODERATE GLOSSINESS	MEDIUM GLOSS
SHEEN	SHININESS AT GRAZING ANGLES		MAT PAINTS, PAPERS AND LOW-GLOSS SURFACES	LOW GLOSS
CONTRAST GLOSS	CONTRAST BETWEEN SPECULARLY REFLECTING AREAS AND OTHER AREAS		PAPERS, MAT AND SEMI-MAT FINISHES, WHITE AND LIGHT-COLORED MATERIALS	LOW GLOSS
ABSENCE-OF-BLOOM GLOSS	ABSENCE OF SMEAR OR EXCESS SEMI-SPECULAR REFLECTION ADJACENT TO REFLECTED HIGH LIGHTS		SURFACES IN WHICH REFLECTED HIGH LIGHTS AND IMAGES MAY BE SEEN	HIGH GLOSS
DISTINCTNESS-OF-IMAGE GLOSS	THE DISTINCTNESS AND SHARPNESS OF THE MIRROR IMAGES	NOT YET MEASURED AS FUNCTION OF APPARENT REFLECTANCE	FINISHES ENAMELS, LACQUERS, GLAZES, AND ALL SMOOTH IMAGE REFLECTING SURFACES	HIGH GLOSS
SURFACE-UNIFORMITY GLOSS	SURFACE UNIFORMITY, FREEDOM FROM VISIBLE NONUNIFORMITIES	NOT MEASURED AS FUNCTION OF APPARENT REFLECTANCE	GLOSS AND SEMI-GLOSS SURFACES OF ALL TYPES	MEDIUM TO HIGH GLOSS

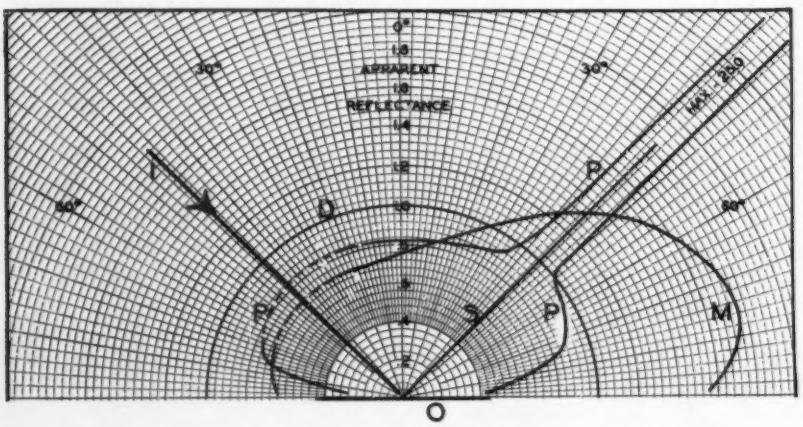


Fig. 3—Apparent Reflectance as a Function of Direction of View.

For a plaque of white, vitreous, enamel on metal *P* and a sheet of mimeograph paper *M*, both illuminated unidirectionally. Direction of illumination *I*, direction of mirror reflection *S*, reflecting surface *O*, reflection distribution for ideal, perfectly-reflecting, perfectly-diffusing surface *D*. (Reproduced from earlier paper (2), Fig. 2, p. 24.)

Although the complete specification of the gloss of a surface involves a whole family of curves, a glossmeter which requires but one setting on the surface tested may serve satisfactorily for measuring the gloss of a limited class of surfaces. The criterion used to evaluate the suitability of a particular instrument for measuring the gloss of a group of samples is the degree of correlation between visual ratings of glossiness provided by trained observers and gloss values which the instrument gives for the same samples.

By comparing the photometric quantities measured by different glossmeters with the different criteria used by observers in rating representative materials for glossiness, one

finds a number of these single-scale methods of rating gloss in use, each one of which requires different apparent-reflectance measurements. The different measurements prove to be suited respectively to different classes of surfaces; and correspondingly, the different classes of surfaces are graded for glossiness according to different appearance criteria. In the previous paper (2), six types of gloss were described. The description is repeated in Table I with some improvements in terminology. Each type of gloss can, in general, be associated with a high, a low, or a medium gloss range within which it yields a best correlation with glossiness. Four of the types of gloss are identified in Table I by diagrams representing the kind of photometric measurement which best specifies the amount of gloss.

METHOD OF SPECULAR-GLOSS MEASUREMENT

The choice of a specular-gloss measurement for classifying paints as "high gloss," "eggshell," "flat," or intermediate between these has appeared obvious. Each of the other types

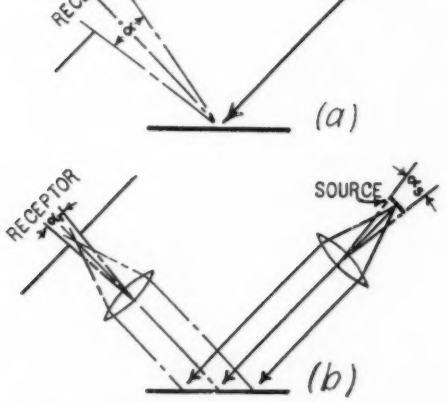


Fig. 4—Two Diagrams of Specular-Gloss Instruments Showing Angular Spread, a.

(*a*) Surface illuminated by single ray of light from point source.
(*b*) Instrument with collimating lenses.

of gloss is restricted in its usefulness either to the high-gloss or to the low-gloss ranges (Table I).

A specular-gloss method is described by: *(1)* angle of view (equal and opposite to angle of incidence), *(2)* spectral characteristics of source and receptor, and *(3)* angular spread from direction of specular reflection of the light which the instrument admits to measurement. The first two of these factors were adequately treated in the previous paper (2). Special attention here will be given to the third factor.

Broadly speaking, we may say that a specular-gloss instrument is intended to measure the proportion of light reflected in the direction of specular reflection when the surface is illuminated unidirectionally. In practice, however, it is necessary that the receptor[4] of a specular-gloss instrument centered to receive light in the direction of specular reflection of the surface as a whole be large enough to accept also light reflected in directions adjacent to this direction of specular reflection. This is required in order that light specularly reflected from glossy surfaces not perfectly flat, or from glossy surfaces not placed in the exact plane chosen for test surfaces, or from an incident beam not perfectly unidirectional, may nevertheless be accepted for measurement as specular gloss. As will now be shown, the "angular spread" of an instrument serves to indicate the range of directions of reflected light accepted for measurement.

If there were a specular-gloss instrument, Fig. 4(*a*), having no lenses, having a narrow beam of light directed onto the test surface, and having a circular receptor opening, the angular spread of the instrument would be measured by the angle, α, of the cone of reflected light accepted for measurement. In Fig. 4(*a*) it can be seen that if light reflected in the direction of mirror reflection passes through the center of the circular opening, the maximum deviation from direction of mirror reflection of light accepted for measurement as specular gloss would be $\alpha/2$.

For large samples measured on the usual specular-gloss instrument which employs lenses and in which the incident and reflected beams are essentially collimated, Fig. 4(*b*), angular spreads are specified by the respective angular extents of source and receptor openings with reference to the centers of the collimating lenses, provided the receptor lens presents sufficient aperture to the test sample. If, however, the angle at the sample subtended by the receptor lens is smaller than the angle at the lens subtended by the receptor slit, the former angle is the effective limiting angle. The sum of source spread and receptor spread, $\alpha = \alpha_s + \alpha_r$, is, for the condition illustrated in Fig. 4(*b*), double the maximum deviation from direction of specular reflection of light which an instrument incorporates in its measurement. This total spread is used hereinafter for the description of specular-gloss instruments.

It is to be noted that the sources of various instruments and the openings through which light is received for measurement may have various forms, circular, rectangular, and so on. For complete description it is necessary to give shapes of sources and openings and all dimensions rather than just one total angular spread. For example, the receptor slit of the McNicholas goniophotometer (Fig. 2) is a pair of jaws which provide a rectangular opening having variable width and constant length. In describing the angular spread used for any particular measurements with this instrument, the variable spread in the plane of measurement, hereinafter called the width spread, is of first importance, particularly where high- and medium-gloss specimens are involved. Any complete spread specification for this instrument must, however, also include the spread perpendicular to the plane of measurement, the length spread, which is 12 deg., considerably greater than the width spreads commonly employed. On this instrument the length spread is the sum of $\alpha_s = 4$ deg., determined from source length compared to focal length of source lens, and $\alpha_r = 8$ deg., determined from receptor lens diameter compared to distance between sample and lens.

MEASUREMENTS AND RESULTS

Using both the photoelectric modification of the McNicholas goniophotometer (Fig. 2) and the Pfund Glossimeter (6) the twenty-four painted plaques mentioned were first measured for specular gloss at three angles of view, 45, 60, and 75 deg., to determine which provided the best separation of the plaques into the classes "high gloss," "eggshell," and "flat." Results from both instruments seemed to indicate that the best separation of the plaques into the classes given by the manufacturers was obtained at 60 deg. For 60

[4] Or the source; see Reciprocal Relations on p. 35 of reference (4).

TABLE II.—Specular Gloss of Painted Plaques.

		Pfund Glossimeter	McNicholas Goniophotometer (with Photox Cell)				
Angle		60°	60°	60°	60°	45°	75°
Spread		8° circular	2.5° by 12°	5.0° by 12°	7.5° by 12°	5.0° by 12°	5.2° by 12°
Reference standard		Black glass = 100	Perfect mirror = 1000 (Specular gloss, per mil)				Black glass = 100
	Plaque:						
High gloss	1G	....	66.5	80.6	83.	46.2	85.3
	2G	90.5	31.2	49.8	57.6	25.3	65.7
	3G	....	83.4	87.9	89.3	50.3	....
	4G	80.0	67.8	76.0	77.1	43.2	89.9
	5G[a]	....	....	....	....	....	52.1
	6G	....	77.2	80.7	82.3	45.8	89.3
	7G	72.9	51.7	64.5	66.4	32.1	78.8
	8G	....	77.4	83.4	85.8	50.6	....
Eggshell	1E	9.0	7.1	14.5	19.6	5.3	37.0
	2E	59.5	34.7	55.9	61.0	26.4	72.7
	3E	11.7	12.6	23.7	30.2	9.1	44.2
	4E	49.5	33.4	54.8	61.9	27.0	70.6
	5E	9.0	8.6	17.9	24.3	8.5	30.6
	6E	29.2	28.7	47.9	56.0	23.4	67.5
	7E	7.3	5.3	11.2	15.4	5.4	37.4
	8E	....	8.7	17.4	21.7	6.1	....
Flat	1F	0.3	1.2	2.4	3.7	1.9	3.6
	2F	0.5	1.4	3.0	4.6	3.1	2.3
	3F	0.5	1.2	2.5	3.8	2.5	2.3
	4F	0.5	1.2	2.5	3.9	2.6	2.9
	5F	0.5	1.3	2.6	3.9	2.6	3.2
	6F	1.3	2.4	5.2	7.3	3.0	9.4
	7F	0.5	1.8	3.7	5.6	3.7	5.3
	8F	....	1.4	2.8	4.2	2.9	....
Black glass		100.	94.	94.	94.	54.	100.

[a] 5G damaged so that it could not be used for measurements left blank.
Measurements with the Pfund Glossimeter made by the late Walter T. Spry of the Munsell Color Co., Baltimore, Md.

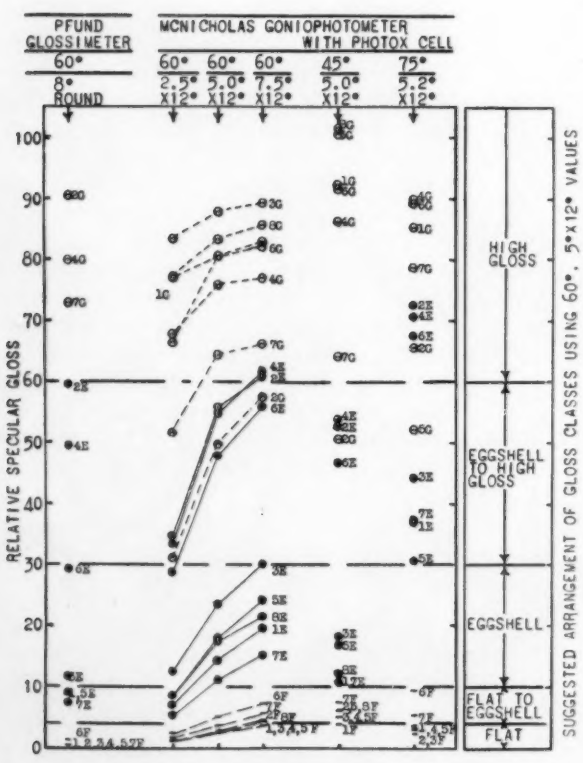


Fig. 5—Graphical Arrangement of Specular-Gloss Data from Table II and a Suggested Arrangement of Gloss Classes Using 60 deg. Incidence and 5 by 12 deg. Angular Spread.

45-deg. values plotted to twice scale readings.

deg. with the goniophotometer, three width spreads were employed.

Measurements on the Pfund instrument made by the late Walter T. Spry at the Munsell Color Co. were the first to indicate that specular gloss at 60 deg. would be suited to the separation of paints into the categories, high gloss, eggshell and flat. As reported by Spry, the source spread of the Pfund instrument is about 8 deg. and the shape of the source round ($\alpha_s = 7$ deg. 50 min.). The spread of the receptor, which is an artificial pupil, is negligible.

Table II gives the results of six sets of specular-gloss measurements made on the twenty-four painted plaques. The reference standard used with each set of data is indicated at the head of each column. The values for polished black glass under the conditions obtaining in the respective columns are also given. Figures from the goniophotometer at 60 and 45 deg. are expressed in per mil specular reflectance; that is, the perfect mirror would be 1000 on the same scale. Throughout the remainder of the paper, specular-gloss values are given on this per mil basis. Additional data on these twenty-four panels obtained with both the Pfund instrument and goniophotometer corroborate those given in Table II.

Arranged graphically, with columns in the same order, the specular-gloss values recorded in Table II are plotted in Fig. 5. In columns 2, 3 and 4 of this figure measurements made at 60 deg. with the goniophotometer are represented. Here as in Table II it is possible to study the effect of change of angular spread on specular gloss. In general, specular-gloss values for surfaces of low specular gloss may be seen, as expected, to vary with spread by proportionately greater amounts than do specular-gloss values of surfaces of medium specular gloss, although the absolute amounts of change are less. The absolute amounts of change for high-gloss surfaces are also less than for medium gloss.

It was noted during the measurements that the effect on specular-gloss of differences in lightness between the plaques studied is not large enough to change the classification in any way importantly. An idea of the influence of lightness may be had by noting the differences in specular-gloss between the lightest ($A_{45°,\,0°}$[5] of plaque 7F = 0.72) and the darkest ($A_{45°,\,0°}$ of plaque 1F = 0.33) of the flat-finish plaques. These two panels are not certainly different in glossiness. The difference in specular gloss between them measures 0.6 per mil for 2.5-deg. width spread and 1.9 for 7.5 deg. It may be concluded that moderate lightness differences need not be taken into account. However, the tendency of dark samples to yield values of specular gloss too low to correlate with glossiness becomes important for greater lightness differences (such as from black to mid gray, or dark gray to light gray).

In the proposed method which follows, it is recommended that values of specular gloss measured at 60 deg. with angular

TABLE III.—Order of Glossiness of Panels as Judged by Four Observers.

Plaque	Rank in Glossiness					Manufacturer's Designation
	Observer 1	Observer 2	Observer 3	Observer 4	Average Rank	
1G	2	4	4	4	3.5	
2G	8	8	7	7	7.5	
3G	3	1	2	1	1.8	
4G	5	5	5	5	5.0	High gloss
5G	6	7	11	6	7.5	
6G	1	2	2	2	1.8	
7G	7	6	6	8	6.8	
8G	4	3	2	3	3.0	
1E	12	16	15	12	13.8	
2E	10	11	8	11	10.0	
3E	14	13	12.5	15	13.6	
4E	13	9	10	10	10.5	Eggshell
5E	15	12	16.5	13	14.1	
6E	9	10	9	9	9.2	
7E	11	15	12.5	16	13.6	
8E	16	14	14	14	14.5	
1F	21.5	21	22	18	20.6	
2F	24	24	22	23	23.2	
3F	18.5	22	22	21	20.9	
4F	21.5	20	22	22	21.4	Flat
5F	18.5	19	18	19	18.9	
6F	17	17	16.5	17	16.9	
7F	20	18	19	20	19.2	
8F	23	23	22	24	23.0	

spreads summing to 5 by 12 deg., or the equivalent, be used to arrange painted surfaces in the five gloss classes: (1) high gloss, (2) high gloss to eggshell, (3) eggshell, (4) eggshell to flat, and (5) flat. One suggested arrangement of boundaries between the classes at 4, 10, 30, and 60 per mil is indicated by the horizontal broken lines in Fig. 5. Another set of boundary values suggested is 4, 16, 36 and 64, which are the squares of 2, 4, 6 and 8, respectively.

These two sets of boundaries were selected for use with specular-gloss measurements at 60 deg. incidence, 5 by 12 deg. spread. It can be seen from Fig. 5 that other measurements of specular gloss might be useful for classifying painted surfaces for gloss and that different boundaries might be chosen for different conditions of measurement. Many of the instruments in use today employ an angle of 45 deg. (1, 3) rather than 60 deg. for specular gloss. In Fig. 5 it can be seen that measurements at 45 deg. incidence do not provide as satisfactory separation of flat from eggshell paints as measurements at 60 deg. The correspondence between results at 45 and 60 deg. incidence is not linear; nevertheless one might for paint samples of a particular type establish the relationship between values from a particular 45-deg. instrument and those from the instrument recommended here. Knowing this relationship, he could use the 45-deg. instrument to determine approximate gloss classifications for paints of the one type.

To examine further the degree of agreement between visual ratings of glossiness and measured specular-gloss values, four observers were asked to rank the twenty-four painted plaques in order of glossiness. The results are given in Table III together with the average of the ranks assigned to each plaque. It may be noted that the four graders grouped the high-gloss, eggshell and flat plaques substantially in agreement with the manufacturers.

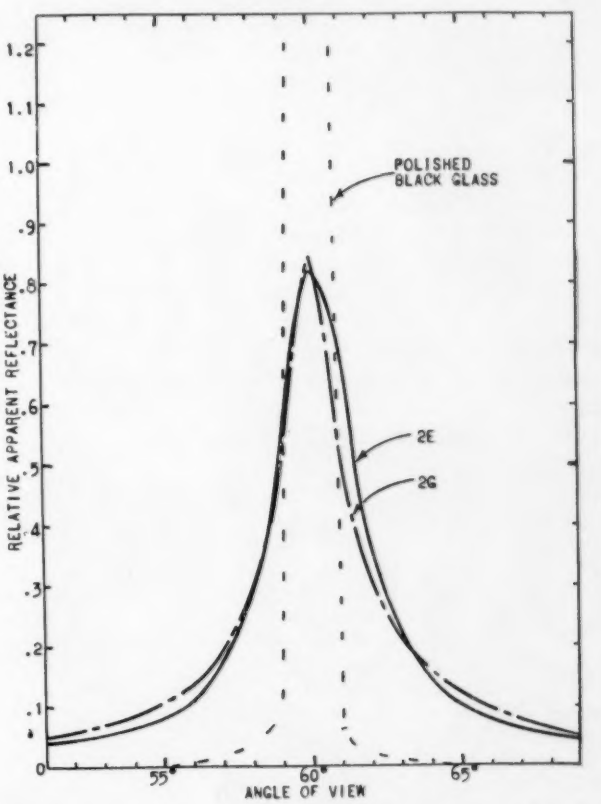


Fig. 6—Goniophotometric Curves of Plaques 2E, 2G, and Polished Black Glass for Near-Specular Directions of Reflection.
Direction of illumination, —60 deg.; width spread, 1.5 deg.

It may be noted, however, from Fig. 5, that the measurements of specular gloss at 60 deg. (5 by 12 deg. spread) served to divide into two groups the eight plaques designated by manufacturers as "eggshell," one a higher gloss group of three which would be classed "eggshell to high gloss" in the arbitrary system indicated in the figure, and the other a lower gloss group of five which falls into the range designated "eggshell." That the separation of these eight paints into two classes is not unreasonable is indicated by the rankings of glossiness given in Table III. Here it can be seen that the three plaques having higher specular gloss (2E, 4E and 6E) also have average glossiness rankings distinctly nearer to high-gloss than do the others. In the same way it can be seen that one plaque (6F) whose specular gloss places it just above the upper limit for flat paints in Fig. 5, has the highest

[5] An explanation of this apparent-reflectance notation is given in the proposed method which follows.

gloss ranking in Table III of any of the plaques designated flat.

But there is one case in which glossiness rankings and results of specular-gloss measurements disagree, namely, plaque 2G. Observers found that this plaque belonged near the bottom of the high-gloss range whereas measurements at 60 deg. with 5 by 12 deg. spread place it in the eggshell-to-high-gloss range. It was accordingly decided to study this plaque further.

Goniophotometric data were taken and reflection-distribution curves drawn for directions of reflection centering about that of mirror reflection for plaques 2G and 2E (incidence, —60 deg.; width spread, 1.5 deg.). These curves together with the curve for a piece of polished black glass obtained under the same conditions are plotted in Fig. 6. Visually, sample 2G appeared glossier than sample 2E (see Table III), but all recent[6] measurements assign the latter a higher specular gloss than sample 2G (see Fig. 5). Actually sample 2G has better distinctness-of-image gloss, as confirmed by the narrower peak in the distribution curve. Sample 2E has approximately equal apparent reflectance for the actual direction of mirror reflection, and in addition, a distinctly higher apparent reflectance for width spreads of from about one to six degrees as indicated by comparisons of the areas under the two reflection-distribution curves for ranges of abscissae one to six degrees in extent. Confirming the curves given in Fig. 6, the data in Table II and Fig. 5 show that the difference in specular-gloss between 2E and 2G is greater for the 5 deg. width spread than for either the 2.5 or 7.5 deg. width spreads. Thus the goniophotometric curves show both the reason for higher distinctness-of-image gloss of plaque 2G and the reason for higher specular gloss of plaque 2E measured at 60 deg. with 5 by 12 deg. angular spread.

Samples 2E and 2G exemplify the trouble which may be encountered in gloss measurements if a device which makes measurements of one type of gloss is employed for the purpose of differentiating samples upon which glossiness ratings are made visually on the basis of another type of gloss. In this instance, it is shown that the method of specular-gloss measurement proposed does not differentiate surfaces according to glossiness, if the surfaces themselves are judged according to the distinctness of images reflected in them. Experience seems to indicate that samples such as 2E and 2G, intermediate between high gloss and eggshell, are ordinarily judged on the basis of distinctness of image. Hence it might be argued that the allocation of such samples to groups should be made by distinctness-of-image gloss instead of by specular gloss. Such a plan would yield a slightly improved correlation with visual estimation in this particular gloss range, but accurate measurement of distinctness-of-image gloss requires more elaborate apparatus than is required for measurement of specular gloss and at least twice as much experimental work. Furthermore, distinctness-of-image determinations would not serve for separating eggshell from flat finishes. In the interest of obtaining a single basis for allocation of all samples to five gloss groups by means of the simplest and most practical instrument, it has been thought best to forego a slightly improved correlation with visually estimated glossiness. Therefore, measurement of 60 deg. specular gloss with 5 by 12 deg. angular spread is advocated. This method usually gives results which correlate with distinctness-of-image glossiness; instances such as that provided by samples 2E and 2G are the exception rather than the rule.

PROPOSED METHOD OF CLASSIFYING PAINTS ACCORDING TO GLOSS

Scope

1. (*a*) *Six Types of Gloss.*—This method defines six types of gloss for describing painted surfaces.

(*b*) *Classification of Paints into Five Specular-Gloss Classes.*—This method defines equipment and procedure for measuring specular gloss and for classifying painted surfaces as either (1) high gloss, (2) high gloss to eggshell, (3) eggshell, (4) eggshell to flat, or (5) flat.

Definitions

2. (*a*) *Gloss.*—The property of a surface by which it reflects light specularly.

(*b*) *Glossiness.*—The appearance ascribable to the gloss of a surface.

(*c*) *Apparent Reflectance.*—The reflectance which a perfectly diffusing surface would require in order to yield the same brightness as the sample under the same conditions of illumination and viewing.

(*d*) *Specular Gloss.*—The ratio of apparent reflectance of the sample, when illuminated unidirectionally and viewed in the direction of specular reflection, to the apparent reflectance of the ideal, completely reflecting, perfect mirror.

(*e*) *Sheen.*—Specular gloss at near grazing angles of incidence and reflection.

(*f*) *Contrast Gloss.*—A fraction whose denominator is the apparent reflectance of the sample when illuminated in a direction other than perpendicular and viewed in the direction of specular reflection, and whose numerator is the same apparent reflectance diminished by the apparent reflectance of the sample identically illuminated but viewed perpendicularly.

(*g*) *Distinctness-of-Image Gloss.*—Indicated by the faithfulness with which the surface produces mirror images of objects.

(*h*) *Absence-of-Bloom Gloss.*—Indicated by freedom from haziness bordering a high light.

(*i*) *Surface-Uniformity Gloss.*—Revealed by the degree of freedom of relatively high-gloss surfaces from visible local variations.

Discussion of Definitions

3. (*a*) *Apparent Reflectance.*—In the measurement of gloss one deals mainly with unidirectional illumination; for such illumination apparent reflectance is a function of the altitude and azimuth of the illuminating beam, and the altitude and azimuth of the direction of view. The gloss of a surface is completely specified by these unidirectional apparent reflectances and is the degree to which apparent reflectance varies with angle. Of principal importance are the specular and near-specular directions of reflection.

In actual cases six determinations corresponding to the six types of gloss defined above have been found sufficient. Five of these may be expressed as functions of apparent reflectance in the plane of the illuminating beam and normal to the surface using the symbol $A_{\theta,\theta'}$, for apparent reflectance where the first subscript indicates the direction of the illuminating beam measured from the normal, and the second subscript similarly indicates the direction of view.

(*b*) *Specular Gloss, Sheen.*—The reference standard used in computing specular gloss or sheen is the perfectly reflecting mirror. Values of specular gloss are expressed in per mil, that is, the specular gloss of the perfectly reflecting mirror is taken as 1000. The working standard is customarily a piece of polished black glass whose specular reflectance is computed by the Fresnel law from its index of refraction. If angle of illumination, dimensions of source, and angular spread of viewing element are stated, specular gloss (G_s) and sheen (G_{sh}) are given by

$$G_s \text{ or } G_{sh} = (A_{\text{sample}}/A_{\text{standard}})_{\theta,-\theta}$$

[6] Measurements with the Pfund instrument were made about one year before the others.

(*c*) *Contrast Gloss.*—If angle of illumination and angular spreads of illuminating and viewing elements are stated, contrast gloss (G_c) is given by

$$G_c = (A_{\Theta,-\Theta} - A_{\Theta,0})/A_{\Theta,-\Theta}$$

(*d*) *Distinctness-of-Image Gloss.*—Distinctness-of-image gloss depends on the rate of change with angle of incidence of apparent reflectance for a direction of view deviating from the direction of specular reflection by a small angle (perhaps from one minute to one degree). A possible quantitative definition of this type of gloss (G_i) is:

$$G_i = (dA_{i,-\Theta}/di)/(k + dA_{i,-\Theta}/di)$$

where $\Theta = i + \delta i$, δi = a small angle of the order of one minute to one degree, and k = an arbitrary constant which should be adjusted once for all to give a convenient scale.

Distinctness-of-image gloss may also be expressed as a function of the least angular separation, $\delta\Theta$, of two linear elements in the illuminant which are resolved in the image. This might give:

$$G_i = K/(K + \delta\Theta)$$

(*e*) *Absence-of-Bloom Gloss.*—Bloom may be exhibited by surfaces whose distinctness-of-image gloss is high and may be quantitatively described by the difference between the apparent reflectance of the sample a few degrees $\delta\phi$ (perhaps 5 deg.) from the direction of mirror reflection and the apparent reflectance many degrees $\Delta\phi$ (perhaps 45 deg.) from it. Absence-of-bloom gloss, G_b, might be indicated by:

$$G_b = k/[k + (A_{\Theta,-(\Theta-\delta\Phi)} - A_{\Theta,-(\Theta-\Delta\Phi)})]$$

Bloom is haziness near a high light. It may be caused by a smear of foreign substance (such as grease) on a plane surface, by small discontinuities in the surface itself, or by light-scattering elements beneath the surface. Bloom from the first two sources is usually an undesirable quantity because it may be the indication of a cleaning process not quite successful, or of the incipient breakdown of a glossy paint film. Bloom from the third source is, however, frequently a desired quantity, and light-scattering materials are sometimes introduced for the purpose of producing it. Such a paint is sometimes said to have a "satiny" finish.

(*f*) *Surface-Uniformity Gloss.*—The dependence of glossiness upon the presence of surface nonuniformities is definite for samples of high gloss, less definite for surfaces of eggshell finish, and obscure or absent for surfaces of nearly flat finish. Surface nonuniformities probably influence judgments of distinctness-of-image gloss more than judgments of other types. Surface nonuniformities include both the regular or semi-regular nonuniformities sometimes called texture (brush marks, orange peel, marks exhibited by etched, pitted, scratched, or wavy surfaces and so on) and the irregular nonuniformities (blotches, isolated scratches, pits, waves, cracks, lines or spots, and so on). Thus far, surface nonuniformity has been treated by visual judgments and by photographs which serve to record the amount and kind of nonuniformity.

(*g*) *Characteristic Appearance of Each Type of Gloss, and Range in Which Each is Most Prevalent:*

Type of Gloss	Characteristic Appearance	Gloss Range in Which Prevalent
Specular gloss	Brilliance of high lights, shininess	Medium gloss
Sheen	Shininess at grazing angles	Low gloss
Contrast gloss	Contrast between specularly reflecting areas and other areas	Low gloss
Distinctness-of-image gloss	Distinctness and sharpness of mirror images	High gloss
Absence-of-bloom gloss	Absence of smear or excess semi-specular reflecti n adjacent to high lights	High gloss
Surface-uniformity gloss	Surface uniformity, freedom from visible nonuniformities	Medium to high gloss

Apparatus Used for Classifying Paints

4. (*a*) *General Description.*—The apparatus shall consist of a light source, a device for orienting the surface of the test object, and a receptor element.

(*b*) *Angles of Illumination and View.*—The angle of incidence shall be 60 deg. from the normal to the sample; the direction of view shall be that of mirror reflection. With a mirror surface in the testing position, the reflected beam shall be centered on the receptor element.

(*c*) *Angular Spread.*—The instrument source and receptor openings shall be rectangular in shape and shall provide total spreads of 5 deg. in the plane of measurement and 12 deg. perpendicular to the plane of measurement, or equivalent spreads shall be used.

(*d*) *Spectral Characteristics of Source and Receptor.*—The source shall be standard illuminant *C* (representative of average daylight) recommended by the International Commission on Illumination (I.C.I.) (8), and the receptor shall have a spectral sensitivity proportional to the luminosity function of the standard I.C.I. observer, or equivalent source-receptor combinations shall be used.

Note.—An incandescent source at a color temperature between 2800 and 3000°K combined with a Photox barrier-layer photocell has been found to be an equivalent source-receptor combination. Any other combination that will give the same results as will the standard combination is also considered equivalent.

Specular-Gloss Standards

5. (*a*) The fundamental specular-gloss standard shall be the ideal, completely reflecting, perfect mirror.

(*b*) Specular-gloss working standards may be highly polished plane black glass surfaces for which the reflectance may be computed as a function of angle of reflectance and refractive index by using Fresnel's equation (1). For specular gloss at 60 deg., polished black glass measures about 90 per mil corresponding to its reflectance of 0.09. Other surfaces sufficiently permanent may serve as working standards if calibrated against polished black glass with instruments of equivalent angular spreads and the same angle of reflection.

Preparation and Measurement of Samples

6. (*a*) Samples shall be prepared on smooth, plane panels; the finish to be tested shall be applied over a suitably prepared ground.

(*b*) The finish shall be as free from brush marks and other surface nonuniformities as possible.

(*c*) In making the measurements, check settings on a standard which has been calibrated for use under like conditions shall be interspersed at time intervals sufficiently brief to insure accuracy of the results to within two per cent of the true values.

(*d*) At least three portions of a test surface shall be measured to give an indication of the degree of surface uniformity and provide an average which is typical of the surface. A sample showing directional regularities (such as brush marks) shall be oriented in its own plane so that the highest specular gloss is obtained.

Reporting Results

7. (*a*) Unless otherwise stated, report values of specular gloss in per mil, that is, the specular gloss of the perfectly reflecting mirror is taken as 1000.

(*b*) The value, if above the eggshell range, shall be reported to the nearest unit; if within the eggshell range, to the nearest 0.5 unit; and, if below the eggshall range, to the nearest 0.2 unit.

(*c*) The particular instrument on which measurements are made shall be identified in form suitable for reference, including angular spreads, and any filters used.

Gloss Classification for Painted Surfaces

8. Surfaces shall be classified as follows:

Surfaces Having Gloss Values	*Classed as*
(*a*) Above 60[a]	High gloss
(*b*) Between 60 and 30	Eggshell to high gloss
(*c*) Between 30 and 10	Eggshell
(*d*) Between 10 and 4	Flat to eggshell
(*e*) Below 4	Flat

[a] The set of borderline values given here is merely one suggested set and is subject to change with further study.

DISCUSSION

The proposed specification may be considered in two parts, the first giving definitions of the six types of gloss, and the second establishing a test procedure for separating paints into five gloss classes. This suggested test procedure for classifying paints is not necessarily applicable to other gloss problems, since different types of surfaces require different methods of gloss analysis (see Table I).

No instrument on the market is definitely known to make the measurements of specular gloss required by the proposed test method. However, the construction of such instruments should not prove difficult and it is almost certain that, should the A.S.T.M. adopt the proposed classification as standard, instrument manufacturers could be persuaded to place suitable specular glossmeters on the market. Some of the inexpensive portable photoelectric instruments for measuring illumination are sufficiently sensitive to serve as receptor elements in instruments of the type required.

For the near future, specular-gloss measurements on additional painted plaques should be undertaken for two reasons. First, additional paints typical of those to which the proposed classification is to be applied should be measured in order to verify the correctness of (1) the suggested method of measurement and (2) the suggested partitioning values. Second, the proposed method of measurement should be tried under the conditions likely to be encountered in practice in order to determine whether additions, notes of caution, or changes in technique are necessary in the proposed A.S.T.M. specification.

Settings for 45 deg., —45 deg. specular gloss with instruments now available should be made to determine whether or not any of these attain a proficiency approaching that of the method proposed here for separating high-gloss, egshell and flat painted surfaces. If any instrument in general use today will make the necessary distinctions with a fair degree of certainty, the fact that the instrument is in general use would be an argument of considerable weight for the adoption of its measuring conditions as standard rather than 60 deg. incidence with 5 by 12 deg. spread. In addition to the better distinction between eggshell and flat paints by the 60-deg. method, however, it is to be noted that 60 deg. ordinarily gives almost twice as much surface-reflected energy as does 45 deg. (for black glass $R_{45°,\ -45°} = 0.054$, $R_{60°,\ -60°} = 0.094$) with, as a consequence, a proportionately smaller demand on photocell sensitivity.

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(6) A. H. Pfund, "The Measurement of Gloss," *Journal*, Optical Soc. America, Vol. 20, p. 23 (1930).

(7) E. D. Ries and C. B. Gilbert, "Gloss and Its Quantitative Measurement," *Proceedings*, Am. Soc. Testing Mats., Vol. 30, Part II, p. 911 (1930).

(8) *Proceedings*, Eighth Session, Commission Internationale de l'Eclairage, Cambridge, pp. 19-29, September, 1931.

D. B. Judd, "The 1931 I. C. I. Standard Observer and Coordinate System for Colorimetry," *Journal*, Optical Soc. America, Vol. 23, p. 359 (1933).

A. C. Hardy, "Handbook of Colorimetry," Technology Press, Cambridge, Mass., (1936).

Standard on Time-Series Charts

IN November there was approved by the American Standards Association as American Standard Time-Series Charts (A Manual of Design and Construction) under the designation ASA Z15.2—1938. This was prepared by the Sectional Committee on Standards for Graphic Presentation, sponsored by The American Society of Mechanical Engineers, under A.S.A. procedure.

The pamphlet incorporating various recommendations has been issued to bring together in convenient form, primarily for the use of the chart designer, procedures which have been found successful in constructing time-series charts. The different phases of chart construction are treated in considerable detail. Discussion and illustrations are largely limited to the type known as the "line chart," but there is discussion of the column and surface types. Topics covered under line charts are layout and design, grids, scale selection, curves, chart designations, etc.

Copies of this 72-page booklet can be obtained from the A.S.A. or A.S.M.E., both at 29 West Thirty-ninth St., New York City, at $1.25 per copy.

Article on New American Pipe Standard

MEMBERS who would be interested in obtaining the article "Use the New American Pipe Standard" by H. H. Morgan and Sabin Crocker, Chairman and Secretary, respectively, of Sectional Committee B36, can procure one by writing Society Headquarters. A quantity of reprints of the article as it appeared in *Heating, Piping and Air Conditioning* have been made available. Copies will be sent without charge to members and others who would be interested.

The article discusses in detail the schedule number series of the B36.10 standard. There are discussions of the limitations of old schedules; the fact that standardization will eliminate useless duplication; the basis of B36.10 standard dimensions; and finally, the desirability of getting the new standard into use.

Address Wanted

Any one knowing the present address of John G. McNulty, whose last known address is 116 Locust St., Aliquippa, Pa., is asked to notify the Secretary-Treasurer.

Discussion of Structural Strength Tests for Concrete Sands

By Fred G. Allison[1]

THIS discussion presents miscellaneous comments on the structural strength of concrete sands, with particular reference to methods used for measuring that factor in the laboratory, in the thought that the discussion might lead toward clearer thinking on the subject. No data are presented and no final conclusions are drawn. In studying present methods or in making efforts to devise new methods for measuring the strength of concrete, cement mortars, or any of their constituents, it is important to have the fullest possible understanding of the nature of such mixtures.

COMPENSATIONS WITHIN CONCRETE MIXTURES

In the practical making of concrete mixtures, it is necessary to deal with a system of multiple ratios, such as water-cement ratio, paste-sand ratio, and mortar-coarse aggregate ratio, all of which are interacting. A very good coarse aggregate may compensate to some extent for a very poor mortar. A very good mortar may compensate to some extent for a very poor coarse aggregate. A very good paste-sand ratio tends to compensate for a relatively poor water-cement ratio. A particularly favorable water-cement ratio tends to compensate for a relatively poor paste-sand ratio. These are but a few illustrations of the many compensations which are possible within a concrete mixture. When economically justifiable, the number of size classes of aggregate may be increased with a high probability of reduced segregation and improved mixtures, when properly combined.

WHAT IS "STRUCTURAL STRENGTH"?

In the consideration of aggregates it is appropriate to ask what is meant by the "structural strength" of concrete sands. Does the term denote particle size distribution, or grading, as it is commonly called? Does it have to do chiefly with the shapes of the grains, with the fact that some of the grains which are used are angular, rough, pitted, porous, or possess a combination of these characteristics, while other grains are dense and smoothly rounded? Does it mean grain strength in the sense of inherent mineral strength, illustrated by quartz being harder than marble? Or does it refer chiefly to what are called impurities, such as organic matter, soft fragments, and conspicuously bad particle shapes? These questions deserve critical thought in connection with all structural strength tests on concrete sand.

In making structural strength tests in laboratories it is common practice to incorporate a proposed sand in a cement mortar and make either tension or compression tests on cured specimens. If the strength of the mortar containing the "unknown" sand is about the same as that of a second mortar, which was made in the same manner but using a standard sand of known quality, it is said that the sand being examined "passes" the structural strength tests. The "unknown" sand may be very little like the standard sand. There may be distinct differences in grading, shapes, mineral strength, and purity. Nevertheless, all possible causes for failure are ordinarily so grouped that in the term "structural strength" literally all the characteristics of a sand must be included. Since this method has been followed in laboratories for many years, it may be very difficult to effect a change unless outstanding reasons for such a change can be shown.

Considering the large majority of sands likely to be submitted for possible use in concrete, it is probable that grading is the most important characteristic and, therefore, in most of our specifications, is rightly placed at the head of the list of desired qualities. The significance of grading has been established by means of mortar strength tests conducted over many years and with a wide variety of sands; yet, strangely, here in this structural strength measurement the equivalent of grading tests is repeated over and over again, although there is no thought of changing the grading specifications to match the findings. On the whole, the most common sand used as a standard in testing laboratories is "standard Ottawa," and the vast majority of proposed sands have been compared with it on the basis of so-called strength, in spite of the fact that the gradings have practically always been decidedly different. This condition has been more or less recognized, and there is an A.S.T.M. method (C 87 – 36)[2] which tends to correct for this inconsistency, although the grading of the sand which is specified for a standard in that method is still far different from the gradings in practical use for construction.

PLASTIC FLOW VERSUS SAND STRENGTH

An examination of efforts made in the past to improve present structural strength tests for sands shows either that the issue has not been clearly defined or that it is difficult to make the test reveal just what is desired. One method incorporated in various specifications, namely C 87, calls for the use of a constant water-cement ratio and the adjustment of the paste-sand ratio at the beginning of the test so as to provide a uniform consistency of mortar. While the method represents a very commendable effort to solve the general problem, it introduces one new and debatable feature. Other conditions being equal, smooth and round sand grains flow most readily. Also, other conditions being equal, the sand with the maximum range in sizes and the smoothest grading curve flows most readily. As a result, in this particular structural strength test, more of a smooth, round, well-graded sand is used with the uniform paste than is used of other sands. Under certain conditions this automatically makes the compressive strength of a mortar go up. Thus are either emphasized or obscured those characteristics of a sand which facilitate or impede plastic flow. It is quite certain that these characteristics are very important, but should not such a test be called a workability test, or a lubrication test, rather than a strength test? There are many reasons for believing that, when concrete design is better understood, it will be found that there is a much closer relationship between work-

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to Society Headquarters.

[1] Research Engineer, Division of Tests, Georgia State Highway Dept., Atlanta, Ga.

[2] Standard Method of Test for Structural Strength of Fine Aggregate Using Constant Water-Cement-Ratio Mortar (C 87 - 36), 1936 Book of A.S.T.M. Standards, Part II, p. 355.

ability (defined as lubrication rather than consistency) and strength than many now suppose.

TRIPLICATE TESTS ARE SUSPECTED

Various investigators in the field of concrete and mortar mixture design have studied the probable errors of different testing procedures and it seems to have been claimed that worth-while comparisons as between two materials and between two methods can usually be made through studying large quantities of data by statistical methods. Those persons who have direct control of the routine testing of concrete constituents and those who are responsible for the final compounding of numerous concrete mixtures are likely to feel that this method of making comparisons is impractical. They want and need simple, direct, and quick indicators of quality. They are likely to feel, and properly so, that differences in quality which can be shown only by duplicate tests, by triplicate tests, or by still further elaboration of the statistical plan, are of questionable significance. In the examination of portland cement it has long been an established practice to make strength tests in triplicate, thereby frankly admitting the inaccuracies of the method. Very much the same situation has existed with regard to our structural strength tests on concrete sands.

IMPORTANCE OF AGGREGATE POSITION RELATIONSHIPS

In studying structural strength tests on concrete sands, much can be learned from the regular method for making strength tests on portland cement. When tension or compression test specimens are made with standard Ottawa sand, the paste is usually considered as the binding agent for the sand. Although that is roughly true in a practical way, it is known that a large part of portland cement itself acts as aggregate, because it does not react with water in ordinary construction. Moreover, if that part of the cement could be removed and a paste be made with the part which can react with water, there would still be some microscopic variations in the density of that paste, when cured. There is a sense, possibly somewhat theoretical but none the less real, in which the denser zones act as aggregate, while the less dense zones act as binder, or bonding agent. It is certain that when a cement-sand mortar is being made, two and possibly three aggregates are being manipulated. In this seemingly simple mortar test not only the combined strength of two or three blended aggregates is measured, but also the way in which the specific technique affects all the aggregate position relationships. Many variables make a high probable error. In this mixture there is a pronounced step in the aggregate grading, a step falling between the smallest sand grains and the largest of the inert cement fragments. So long as this relatively great step in aggregate grading is present, any adjustment in ratios or manipulative details aimed at regulating the spacing of either the inert or active cement fragments within the paste is thereby limited in effectiveness. It is apparently tacitly assumed that, aside from whatever effect the simple water-cement ratio may produce, a chance arrangement of these cement particles is quite sufficient, because that duplicates practical construction. This is very much of a debatable point and it should be more generally realized that in this test the water-cement ratio used is not normal to construction; the sand is highly impractical from a construction standpoint and the work applied to the test mortar little resembles that done during practical concrete construction.

QUALITIES OBSCURED OR EMPHASIZED BY TESTING PROCEDURE

If there were two sands both of appropriate grading and purity, both alike except that one was made of hard quartz and the other of soft marble, the difference in true mineral strength might be either emphasized or obscured by a skillful adjustment of a test procedure. An adjustment aimed at producing such effects in the case of tension tests might not produce the same effects in the case of compression tests. In order to give the largest possible numerical value to the difference in strength with a tension test, a low water-cement ratio and a low paste-sand ratio would be used. This would tend to force the rupture largely through the sand grains and thereby reveal the maximum difference in mineral strength. In order to obscure the difference in mineral strength with a tension test, a high water-cement ratio and a high paste-sand ratio would be used. This would tend to permit the rupture to pass largely through the cured paste and would show a minimum difference in sand strength. With compression tests, differences in mineral strength might be emphasized with a high water-cement ratio and a low paste-sand ratio, while they would tend to be obscured by a low water-cement ratio and a high paste-sand ratio. That the necessary adjustments in order to produce these effects are different with compression tests than with tension tests is due to the fact that in the tension tests the bonding agent (in this case the cured paste) contributes little, if anything, to strength through impeding the slipping of one aggregate unit on another, whereas, in the compression test such impedance may be an important function of the bonding agent. Thus is illustrated one of the simplest cases of the effect upon the apparent strength of concrete sands of adjusting the multiple ratios. If, along with such adjustments in multiple ratios, adjustments in angularity and grading factors are also introduced, the total number of possible combinations obviously could increase enormously, and the difficulties in the way of a clear-cut analysis of the situation could grow proportionately.

The very first thing to accomplish in improving the present method for testing the structural strength of concrete sands is to decide what information is actually wanted. Probably many people who work with concrete think that by the term "structural strengh" of sand they mean its mineral strength. If this should be the best attitude, it is possible that the simple and common-sense thing to do is to obtain or prepare a series of standard sands, each one of which meets standard grading specifications. These sands might be so selected that they would provide considerable variety as regards the angularity group of characteristics. When a proposed sand arrives in the laboratory, it could be first examined for shape qualities and be matched against one of the standards. It could next be regarded to match exactly the grading of that same standard. Tests properly made on these two sands should show something about the comparative mineral strengths without the issue being confused with grading and angularity factors.

OUTER AND INNER PATTERNS

Although it is common practice in engineering work, especially that part of it which deals with the strength of

materials, to speak of tensile strength and compressive strength as if they were actual properties of solid materials, the fact is, in practical tension and compression tests the measurements really show the effects of the external and internal patterns of specimens. Undoubtedly this is as true of an individual mineral fragment, regardless of size, as it is of a massive concrete structure. Unless a sharp distinction is drawn between the parts played by each of these patterns, it is easily possible to misconstrue many test results. In engineering design it is well understood that the two patterns should be harmonized. The truth of this needs even fuller recognition in testing work. Sometimes, particularly in compression tests, an external pattern can be so selected as to tend to obscure internal variations in strength.

An immense amount of research work has been done on concrete design and upon the testing of concrete constituents, but many questions remains unanswered. New test methods for cement and sand are on the way, and it is to be hoped that vigorous and concerted efforts to perfect such methods will find appropriate backing and encouragement.

Student Membership Prize Awards

ANNOUNCEMENTS of the Student Membership Prize plan in effect in a number of engineering schools and universities have appeared during the past few years in the BULLETIN. It is thought desirable again to include some details of this plan so that all members may be familiar with it.

In short, the plan provides that selected engineering students in various schools will be awarded student memberships in the Society. These awards are underwritten by members of the Society who contribute the annual dues of $1.50 for each student award.

The basis of the award is decided upon by the donor in consultation with the engineering dean or some faculty member in the respective school. Some are awarded for outstanding work in testing of materials, others for excellent work in courses involving materials. In general the students are selected because of interest in work they have done in the field of engineering materials.

The awards that have been made in the past few years have resulted in interesting quite a large number of students in the Society's work and keeping them in touch with work in the field of materials. Not only do the students benefit, but the plan may mean much to the Society by acquainting the students with the importance of the Society's work.

A list of schools in which awards have been established, together with the A.S.T.M. members who sponsor the awards, follows:

Massachusetts Institute of Technology—A. W. Carpenter
Rensselaer Polytechnic Institute—Herbert Spencer
University of Kansas—Walter Bohnstengel
University of Idaho—A. E. Peterson
University of Pennsylvania—C. L. Warwick
Detroit Institute—F. O. Clements
Grove City College—A. E. Pew, Jr.
University of Illinois—S. H. Ingberg
Iowa State College—H. P. Bigler
Cornell University—F. M. Farmer
Worcester Polytechnic Institute—S. Collier

The total number of awards at these 11 institutions is 51.

There are some very interesting letters from students and faculty members in connection with the awards. One professor listing those selected by his faculty as prize winners wrote "Not only has the work of these students been of high quality but I believe they are of such type mind that they would be able to gain considerable benefit from membership in the Society. I know that several of these men are sufficiently interested in materials to have selected our newest option in Mechanical Engineering which deals primarily with materials of engineering."

A note from a student included the following: "I am sure that my membership in the Society will be a real service to me. The book I selected, A.S.T.M. Standards for Students in Engineering, and the ASTM BULLETINS will surely prove valuable to me since they will enable me to keep in close contact with the progress being made in the field of materials. It is quite possible that this award will be a deciding factor in the selection of my major. So you can easily see how important it is to me."

For the dues of $1.50 student members can obtain a copy of any one of the special compilations of standards, they get the ASTM BULLETINS, can obtain the Year Book, any or all preprints of technical papers or reports and can purchase Society publications at greatly reduced prices.

Members of the Society who may wish to obtain further information with respect to the establishment of these awards can do so by writing A.S.T.M. Headquarters.

World Automotive Engineering Congress

A VERY extensive program is being developed for the 1939 World Engineering Congress of the Society of Automotive Engineers, the tentative program listing some sixty technical papers by outstanding authorities; over one-third of the speakers are Europeans. The Congress opens May 22 in New York for a five-day session, will be in Indianapolis May 29 to 30, in Detroit May 31 to June 2, and closes with a three-day session in San Francisco, ending June 8.

Advanced engineering design problems of aircraft, automobiles, trucks, buses, railcars, the role of tractors in our national economy, operating problems of fleet owners, and exhaustive reports on fuels and lubricants developments will be covered by the Congress.

The S.A.E. has extended an invitation to A.S.T.M. to participate in this Congress. Quite a number of members of the Society are listed on the technical program. Dr. T. G. Delbridge, The Atlantic Refining Co., is to be chairman of the general session in New York on Monday evening, May 22. Outstanding speakers in the aircraft and automotive fields are scheduled to participate in the various cities including: C. F. Kettering, E. V. Rickenbacker, W. S. Knudsen, F. M. Zeder, K. T. Keller, D. G. Roos, and many others. The Congress program has been developed by the Meetings Committee of the S.A.E. headed by R. R. Teetor of the Perfect Circle Co. Members of the A.S.T.M. who wish to obtain further details of this Congress are requested to contact the S.A.E. Office, 29 W. Thirty-ninth St., New York City.

1939 New York World's Fair—Opening April 30

MANY members have indicated that they will combine their trip to the 1939 A.S.T.M. Annual Meeting with attendance at the New York Fair which opens on April 30, visiting the Fair before or after their attendance at the meeting. Many members are expected to bring their families with them. The importance of making hotel reservations early has been stressed. Those who will be coming by train undoubtedly will check carefully into the special rates which are in effect, the railroad rates to the Fair providing for stopover privileges at Atlantic City. Many members probably can take advantage of these special rates.

Obviously it is impossible to devote much space in the BULLETIN to discussions of the Fair. An Official Guide Book is being published, information on which can be obtained from Macfadden Publications, Inc., Room 1002, 33 W. 42nd St., New York City. There has been much publicity in the press and in other ways. A few points, however, might be mentioned, the information being based on statements prepared by the Fair Department of the Press.

The area covered by the Fair site is 1216½ acres, being about 3½ miles long and 1¼ miles wide. The site is just 8½ miles from Times Square *via* the Queensborough Bridge. The Trylon is the highest structure (700 feet high) but there are a number of other high structures including the Parachute Jump, 250 ft.; Russian Tower, 259 ft.; and Belgian Carillon, 155 ft.

The total Fair investment is estimated at $155,000,000, exhibitors participating to the extent of about $35,000,000; foreign governments, $25,000,000; New York City, $20,000,000; the Fair Corporation itself having about $50,000,000 invested. There are some 1500 exhibitors. Sixty-one foreign governments and the League of Nations are represented.

Some of the estimated quantities of materials used are interesting.

Piles	63,000 Tons
Steel—structural	42,000 Tons
Steel—reinforcing	2,000 Tons
Cement	15,250 Tons
Sand, Gravel and Crushed Stone	130,000 Tons
Paint	1,000 Tons
Copper Wire	1,415 Tons

It is estimated there will be 28,000,000 sq. ft. of wall board and roofing material and about 50,000,000 board feet of lumber.

An intramural bus system will operate over ten miles of the Fair highways. These buses will be the largest passenger vehicles in the world. Some thirty stations have been established.

It is estimated that 10,000 trees will form part of the landscaping and that 250,000 shrubs and 1,000,000 bulbs and about three-quarters of a million bedding plants will be used in the landscaping program.

First official painting of New York World's Fair 1939, by H. M. Pettit, shows major arterial, subway, railroad and other lines which tie Fair to mainland. Extreme upper right is Whitestone Bridge route from New England and Canada; next in order come Flushing Bay boat piers, North Beach airport and Grand Central Parkway Extension to Triborough Bridge. Paralleling this side of grounds are tracks of Long Island Railroad and I.R.T.-B.M.T. subways, while Fair station of Independent Subway may be seen at bottom center just left of World's Fair Boulevard, which bisects grounds and connects directly with Queensborough Bridge. Other main arteries lead to Williamsburg, Manhattan and Brooklyn Bridges.

Main exhibit area lies north of World's Fair Boulevard with buildings and displays of 1,400 exhibitors on tree-shaded avenues radiating in rainbow colors from pure white Perisphere and Trylon. Extending diagonally to lower right from this Theme Center is Constitution Mall leading to fountain-studded Lagoon of Nations and Government Zone where twin-towered Federal Building and exhibits of 62 nations center on 7-acre Court of Peace. Between Lagoon and Boulevard rises 12-acre Court of States group housing displays of most of 35 exhibiting commonwealths. South of Boulevard lies 280-acre Amusement Area, its quaint villages, gay restaurants, thrilling rides and shows fronting on Fountain Lake, scene of nightly fire and water shows.

New Method of Measuring Deflection in the Transverse-Loading Test of Cast Iron

By A. I. Krynitsky[1] and C. M. Saeger, Jr.[1]

One of the most important determinations to be made in the transverse-loading test of cast iron is deflection. This is particularly true in the case of the newly developed high-strength cast irons for which a knowledge of the elastic and the plastic deflection is often desirable. For these determinations, complete stress-strain curves obtained by applying the loading in progressively increasing steps are necessary, the total deformation under each load and the permanent set or plastic deformation after the load has been removed being determined for each step. The difference between the two is considered as the elastic deflection of the bar.

The separation of the elastic deformation from the plastic deformation was first studied approximately 50 yr. ago by deSegundo[2] and also by Bach[3]. The most recent research on this subject was made by Pearce[4] who investigated a wide variety of cast iron bars of various shapes and sizes, using the step-loading method. The method of measuring deflection in this case should be not only as exact as possible but it ought to permit the carrying out of deflection measurements under step-loading up to the breaking point and also the determination of plastic deformation at practically zero load for each step-loading. One of the first requirements for the deflection measuring apparatus is that it should be entirely independent of the testing machine. Direct observation of the changing position of the bar is unsatisfactory because it involves a number of assumptions, for example, that the supports and the testing machine as a whole remain immovable and that there is no penetration of the supports into the specimen. To avoid these possibilities of error a new method of measuring deflection was devised.

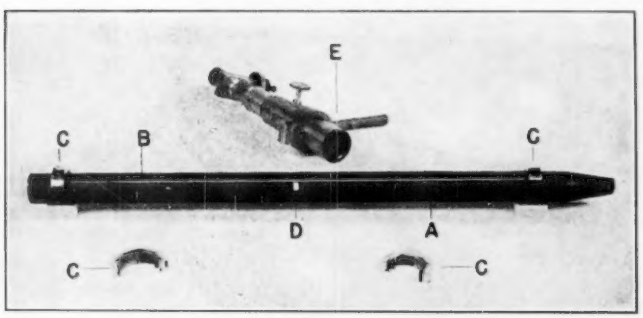

Fig. 1—Apparatus for Measuring the Deflection of Test Bars Under Transverse Loading.

A—Cast iron test bar.
B—Rubber band.
C—Clamps.
D—Reference mark.
E—Micrometer telescope.

NEW METHOD OF MEASURING DEFLECTION

In the method of measuring deflection of bars under transverse loading described here, a rubber band, *B*, is stretched tightly along the length of the bar, *A*, and is held in position by two clamps, *C*, as shown in Figs. 1 and 2. Metal strips on the inner surface of the clamps keep the rubber band near to, but not in contact with, the surface of the bar at all times. The spacing between the two clamps is the same as that between the supports for the bar in the testing machine—18 in. in these experiments.

A small piece of paper, *D*, is cemented to the surface of the bar midway between the clamps, and the upper edge of this piece of paper is considered as a reference mark. In conducting the test, the bar is placed in the testing machine (Fig. 2) and a micrometer telescope, *E*, mounted at a distance of 20 in. from the bar, is used to measure the distance between the lower edge of the rubber band and the reference mark. An important feature of this method is that the micrometer telescope is mounted on a support that has no connection with the testing machine.

The rubber band clamped to the bar at the two supports remains as a straight line and there is a relative motion between it and the reference mark on the surface of the bar. This relative movement is a measure of the deflection of the loaded bar, and a similar measurement after the load has been removed indicates the permanent set. With this method the maximum error in reading deflections, including errors in the micrometer telescope and personal errors of the observer, was found to be less than plus or minus 0.002 in.

The principal advantage of this method of measuring deflections is that the readings are made entirely independently

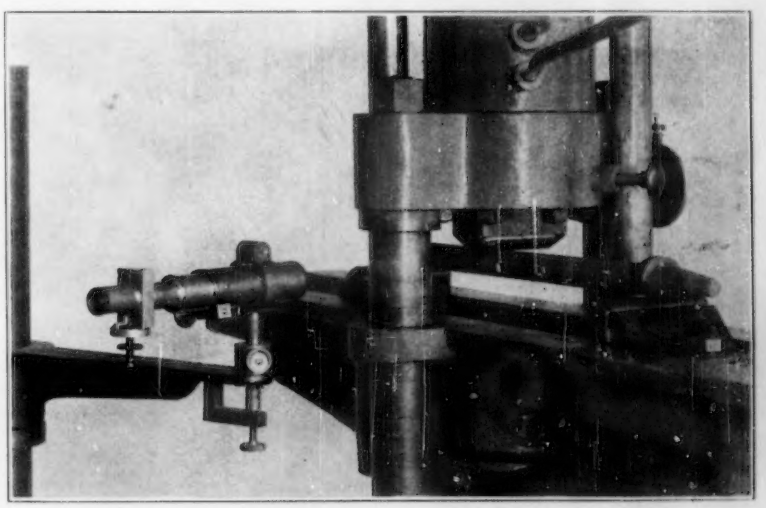

Fig. 2—Test-Bar Equipped with the Rubber Band and Reference Mark Mounted in the 50,000-lb. Amsler Universal Testing Machine and Micrometer-Telescope Placed Independently from the Testing Machine.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to Society Headquarters.

[1] Associate Metallurgist, and Senior Metallurgist, respectively, National Bureau of Standards, Washington, D. C.

[2] E. C. de Segundo, "Experiments on the Strain in the Outer Layers of Cast Iron and Steel Beams," *Proceedings*, Inst. Civil Engrs., Vol. 98, p. 308 (1888-1889).

[3] C. Bach and R. Baumann, "Elastizität und Festigkeit," Ninth Edition, Julius Springer, Berlin, Germany (1924). First edition of this book was published in 1889.

[4] J. G. Pearce, "The Elasticity, Deflection and Resilience of Cast Iron," *Journal*, Iron and Steel Inst., Vol. 129, I, p. 331 (1934).

of the testing machine and supporting fixtures. A further important advantage is that measurements can be continued up to and including the breaking load without danger to delicate instruments, such as an extensometer or a dial micrometer.

PRACTICAL APPLICATION OF THE METHOD

This new method was employed at the National Bureau of Standards in a recent study of the elastic properties of cast iron[5]. Some of the results obtained are summarized here to illustrate its usefulness. Three cast irons having the compositions shown in Table I were studied.

Table I.—Composition of Stock Pig Irons.

Iron	Total Carbon, per cent	Silicon, per cent	Manganese, per cent	Phosphorus, per cent	Sulfur, per cent
A	3.44	1.40	0.15	0.46	0.020
B	3.79	1.40	0.63	0.181	0.062
C	3.44	2.43	0.77	0.395	0.050

In connection with the results obtained, a summary of the procedure in casting the bars is of interest. Test bars, 21 in. in length and 1.2 in. in diameter, were cast vertically in sets of four, in green sand molds by the bottom-pouring method. Four melts of the same iron were made, which were heated to predetermined maximum temperatures of 1400, 1500, 1600 and 1700 C., respectively, each melt being poured at temperatures corresponding to 100, 150, 200 and 250 C. above the temperature of the liquidus for that particular iron. Thus, 64 test bars were prepared from each of the cast irons used. All bars were tested as cast.

A Universal testing machine of the hydraulic type of 50,000-lb. capacity was used in testing the bars. The rate of loading of all bars corresponded to 0.12 in. per min. travel of the free head of the testing machine.

A test bar, equipped with the rubber band and reference mark, as shown in Fig. 1, was mounted in the testing machine on two supports of the roller type at a span of 18 in. (Fig. 2). The bar was adjusted until the rubber band lay in the horizontal plane of the neutral axis of the bar. A load of 50 lb., which was sufficient to seat the bar firmly but was not enough to produce noticeable deflection, was applied and the distance between the lower edge of the rubber band and the reference mark was determined and used as the zero reading. The deflection of the bar was then measured as it was loaded in a series of steps of 100 or 200 lb. each. After the load had reached 800 or 1000 lb., each application of load was followed by unloading to the original 50-lb. load, and the permanent set in the unloaded bar was determined. Measurement of the small permanent deformations that resulted from loads of less than 800 or 1000 lb. were considered unnecessary after a few initial measurements. Unloading of a bar did not affect its deflection under subsequent loads; the breaking loads and the load-deflection curves of duplicate bars were practically identical when one of the bars was loaded in the manner just described and the other was progressively loaded to failure, without unloading between successive loads.

The total deflection at breaking load and the "set" of each bar under increasing step loadings were determined and the elastic deflection was taken as the difference between the total and the plastic deflection for each load. The relation between load and total, plastic, and elastic deflections of representative bars of iron A, B, and C is shown in Fig. 3.

The curves shown are typical for all bars tested in the study of the elastic properties of cast iron[5]. The freedom from scatter in the results is noteworthy; in each case the plotted points formed a smooth curve. In all cases the total deflection curve is a continuous curve inclining progressively toward the deflection axis. The curves for plastic deflection for loads of 800 lb. or more, likewise, are continuous curves without straight portions. The elastic deflection curve is linear only in its lower portion. For iron A, the linear portion extends to some load between 1400 and 1800 lb. for

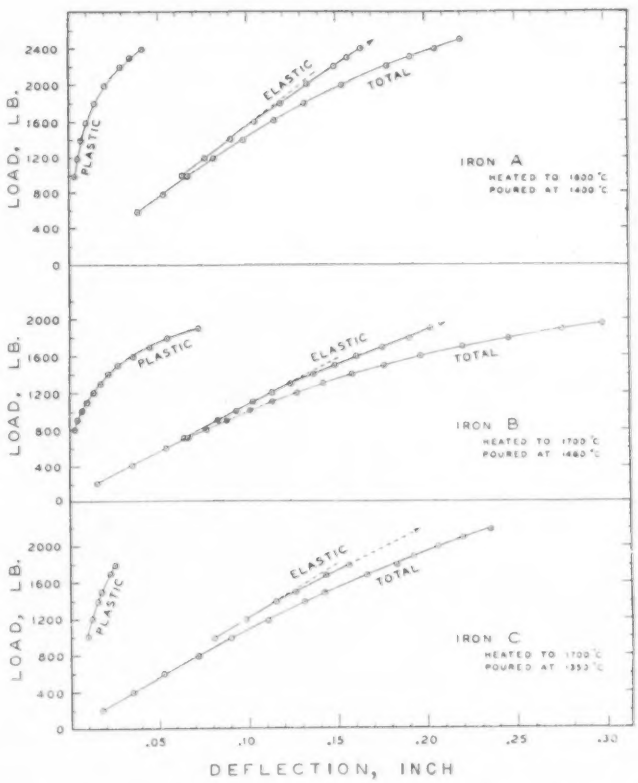

Fig. 3—Typical Plastic, Elastic, and Total Deflection Curves of Irons A, B, and C.

each of the bars. For irons B and C it extends to the range of loads from 1200 to 1400 lb. Above the linear portion each curve inclines toward the deflection axis.

The results were reliable enough to justify the determination of the relative modulus of elasticity and resilience values.

Complete information on the transverse properties of cast iron is not obtained by the ordinary transverse strength test. In order to determine the elastic and plastic deflection, the method of step loading and unloading must be employed. From the straight portion of the elastic deflection curve a relative modulus of elasticity may be calculated, whereas from the slope of a straight line drawn from the origin of the stress-strain curve to any point on that curve only a secant modulus of elasticity may be determined. It may be reasonably believed that the relative modulus of elasticity, as determined from the straight portion of the elastic deflection curve, expresses more accurately the elastic rigidity of cast iron than does the secant modulus.

[5] A. I. Krynitsky and C. M. Saeger, Jr., "Elastic Properties of Cast Iron," *Journal of Research*, Nat. Bureau Standards, Vol. 22, p. 191 (1939) *(Research Paper No. 1176)*.

Tests on the Thermal Endurance of Glass

By S. R. Scholes[1]

EDITOR'S NOTE.—This paper is a development of work which Professor Scholes has under way to perfect a satisfactory method for determining the thermal endurance of glass. The project is part of the activities of Subcommittee IV on Physical and Mechanical Properties of A.S.T.M. Committee C-14 on Glass and Glass Products. (See *Proceedings*, Am. Soc. Testing Mats., Vol. 38, Part I, p. 356 (1938).

THERMAL endurance has been regarded as specific for a glass of any given chemical composition. In the old formula announced by Winkelmann and Schott, this property was held to depend upon a number of factors: coefficient of thermal expansion, tensile strength, modulus of elasticity, specific heat, density, and thermal conductivity. The later view seems to be that the last three properties, which are concerned with the diffusivity of heat through the glass, do not enter into its thermal endurance to any appreciable degree. Furthermore, since the tensile strength and modulus of elasticity of different glasses do not differ widely, it has been still more recently suggested that for all practical purposes the thermal endurance of a glass depends inversely upon its coefficient of thermal expansion.

Glass may be tested for thermal endurance in the form of actual pieces of commercial ware as in the routine testing in factories, or in the form of specimens of some regular geometric shape. The latter method seems to offer the best approach for comparative purposes, because of the ease with which the size and shape of specimens from different compositions may be duplicated, and because the disturbing factors present in glasswares, such as variation in thickness between different pieces and in the same piece, and peculiarities of shape and section that give rise to stresses not easily foreseen or estimated may thus be eliminated.

In the present investigation, specimens were treated in the form of cylindrical rods approximately six inches in length, and the process consisted in heating the rods to a predetermined temperature and plunging them suddenly into water at 20 C. The temperature drop, or sudden change in temperature necessarily undergone by the surface of the rods, is sometimes designated as θ, and this symbol will be used in the present discussion. The value of θ for a given specimen, as describing its thermal endurance, is held to be that temperature difference at which there is an even chance of breakage and of survival.

The apparatus used is similar to that designed by W. C. Taylor, of the Corning Glass Works. In the present investigation the heating furnace was made by molding seven copper pipes of $\frac{1}{2}$-in. bore, tied together in a hexagonal shape by wire, into a cast aluminum cylinder 10 in. in length by 3 in. in diameter. This cylinder was made the core of an electric heating unit wound with sufficient resistance wire so that it developed between 250 and 300 watts. The core was surrounded by rock-wool insulation, and the whole enclosed in a sheet-metal cylinder 6 in. in diameter. With this device, a heating rate of from 6 to 10 deg. per minute could be maintained, but the rate of cooling was of the order of $\frac{1}{2}$ deg. per minute. This heating device was clamped upright in a steel frame, and closed at the lower end by a sheet-metal lid, pivoted to swing aside and allow the rods contained in the several holes to drop into a pail of water placed beneath the heater. One of the holes was used for a base-metal thermocouple, and six rods were treated at one time. The top was closed with a pad of rock wool.

By manual operation of the switch controlling the heating element, the temperature could be maintained constant within ± 1 deg., as indicated by the potentiometer, for the 5 min. which was decided upon as the time necessary for the specimens to reach the indicated temperature to a sufficient depth for the test. Longer intervals of heating were tried from time to time without measurable difference in the results. The quenching pail contained about two gallons of water, easily adjusted to 20 $\pm$ 0.5 C. (thermometer) by the addition of small quantities of cold or warm water as required.

Two types of glass were tested. One lot of rods was supplied by the Corning Glass Works, and consisted of Pyrex canes in $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$-in. diameters approximately. The other lot of canes was supplied by the Kimble Glass Co., and was of ordinary lime glass. The rods were first tested as received, in the strained condition normally resulting from the drawing and rapid cooling in air. Much difficulty was experienced in cutting these rods into short lengths without getting badly splintered ends, and recourse was had to a carborundum disk for all except the $\frac{1}{4}$-in. size, which could be scratched with a file and broken into lengths in the usual manner.

In the quenching test, no difficulty was experienced in observing fracture in the $\frac{1}{2}$-in. rods in the strained condition. These broke, almost without exception, squarely across at practically a right angle to the axes of the rods. The rods of $\frac{3}{8}$-in. diameter often showed an interesting spiral fracture coiling practically the entire length of the rod, with an interval between cracks of about $\frac{1}{2}$ in. A few of the $\frac{3}{8}$-in. rods broke crosswise, and a few split. The breaks in the $\frac{1}{4}$-in. rods were a little more difficult to find, but could be observed almost entirely as irregular, lengthwise splits with some tendency to form spirals. When breaks occurred only at or near the ends, where cracks were started by the cutting-off process, they were not counted.

After annealing, the rods could all be cut very easily by file-scratching, and they broke across cleanly without splintering, even in the largest size. The breaks in the quenched annealed rods were practically all of the same type, namely, lengthwise splits. This may possibly be accounted for by two causes. One is that here the circular stress developed by the sudden contraction reaches a limiting value sooner than does the lengthwise stress. The other possible cause is that in the process of manufacture, seeds and inhomogeneities are stretched out lengthwise, and thus set up lines of weakness where fracture may originate. In the larger, strained rods, the annular compression opposing fracture seems to be stronger than the lengthwise compression, thus bringing about crosswise breakage.

Another marked difference in the behavior of the strained and annealed rods was the greater value of θ for larger diameters. This was more especially true of the lime glass, where the coefficient of expansion is much greater, and the

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to Society Headquarters.

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consequent degree of strain or disannealing is much higher. Further discussion of the results will be postponed until after tabulation of the numerical values.

As in all tests involving the strength of glass, a great scattering of values for θ is observed, and a large number of trials is necessary to the selection of a mean. For example, in the thermal-shock testing of Pyrex rods, $\frac{1}{4}$ in., unannealed, 48 experiments were made with 6 rods each. Temperature differences of 240 to 275 C. were employed, with larger numbers of runs made at the intervals where approximately half the rods broke.

At the 270 C. interval, the following results were obtained:

Runs	Broken	Total Broken
2	0	0
1	1	1
5	2	10
5	3	15
2	4	8
1	5	5
1	6	6
17		45

Average number broken, 2.6; percentage broken, 44.

Obviously, this typical group of data can be plotted into the common bell-shaped curve of distribution.

When the mean values of percentage broken for the various temperatures have been selected, they may be plotted as in Fig. 1. The probable value, for the temperature interval where chances of survival are even, may be found by noting where the ordinate for 50 per cent crosses the curve; in the present instance this is 270 $\pm$ 5 C.

By the above method, the following thermal-shock values were obtained:

	Annealed Rods		Unannealed Rods	
Diameter, in.	Pyrex Glass	Lime Glass	Pyrex Glass	Lime Glass
$\frac{1}{4}$	245 C.	85 C.	270 C.	135 C.
$\frac{3}{8}$	190 C.	75 C.	260 C.	150 C.
$\frac{1}{2}$	170 C.	65 C.	260 C.	160 C.

The above values for θ were obtained on rods as cut, either by carborundum saw or by file. A series of tests on similar rods whose ends had been thoroughly fire-polished gave the same values, within experimental error.

Another series of experiments on a different lot of Pyrex rods, in which the strain was apparently very high, gave the surprising value of 370 C. for θ. When some of these rods were fire-polished on the ends, the thermal-shock value dropped down to 240 C., and the breaks all occurred near the ends, where the original uniformity of strain was upset by the heating process.

TESTS ON SPHERES

About 300 glass spheres (marbles) $\frac{3}{4}$ in. in diameter, made of light-green lime glass, were heated in a vertical tube furnace and dropped into water, in lots of six. The results are shown in Fig. 2. The indicated thermal shock value is 76 C. Five test runs at 77 C. resulted in 52 per cent breakage. At this temperature or lower, the marbles that broke split almost exactly in half, with occasional quartering. Although spheres are excellent, from the standpoint of getting close values, the extreme difficulty in getting specimens makes their use almost prohibitive because of cost.

DISCUSSION OF RESULTS

The thermal-shock values for the annealed rods of Pyrex and lime glass are roughly in inverse proportion to the coefficients of expansion, α, 32 $\times$ 10^{-7} and 91 $\times$ 10^{-7}, respectively:

Diameter, in.	Glass	θ	$\alpha(10^7)$	$\theta \times \alpha(10^7)$
$\frac{1}{4}$	Pyrex	245	32	7840
	Lime	85	91	7735
$\frac{3}{8}$	Pyrex	190	32	6080
	Lime	75	91	6825
$\frac{1}{2}$	Pyrex	170	32	5440
	Lime	65	91	5915

For the strained rods, this relationship is not even approximate. It is evident that the lime glass rods are much more strongly disannealed or toughened in the usual process of drawing and air-cooling.

Finally, it is obvious that thermal shock tests on rods, so far as they serve to compare the thermal endurance of glasses, must be carried out on annealed specimens.

These experimental thermal-shock values may have no close relation to the behaviors of different glasses in ware.

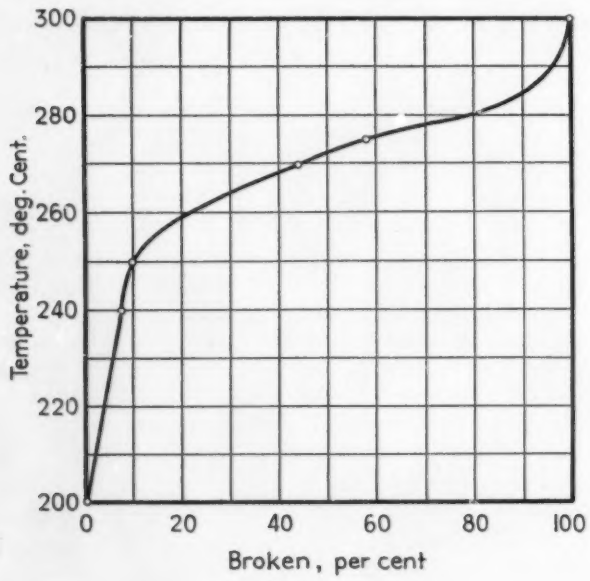


Fig. 1.

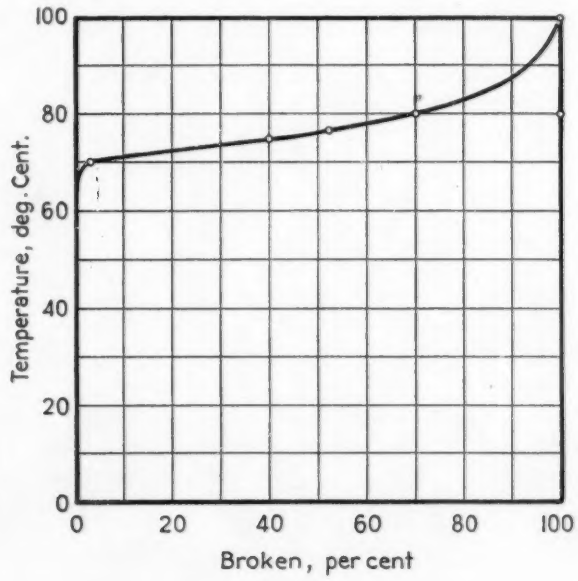


Fig. 2.

Precision Radiography

By Gilbert E. Doan[1]

SMALL defects, such as shrinkage cracks, lack of fusion and porosity in welds or other metallic bodies, require radiographic methods of high sensitivity for their detection. This paper reports studies undertaken to render this detection certain and dependable. It undertakes also to provide a mathematical method for deciding upon the shortest distance at which the radiant source can be set from the object. The shortest exposure time will thus be used, and yet all flaws of a size which are considered harmful will be revealed.

It is at first strange that the method of detection of these very small flaws can best be explained by observing some of the largest bodies in the universe: the sun, the earth, and the moon, but these bodies make the explanation far easier to follow.

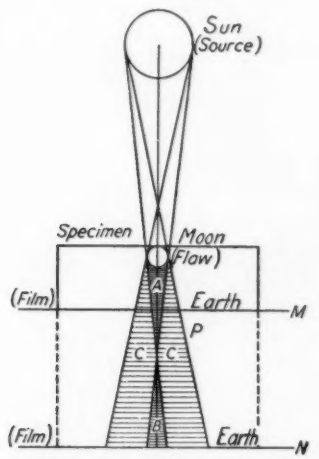
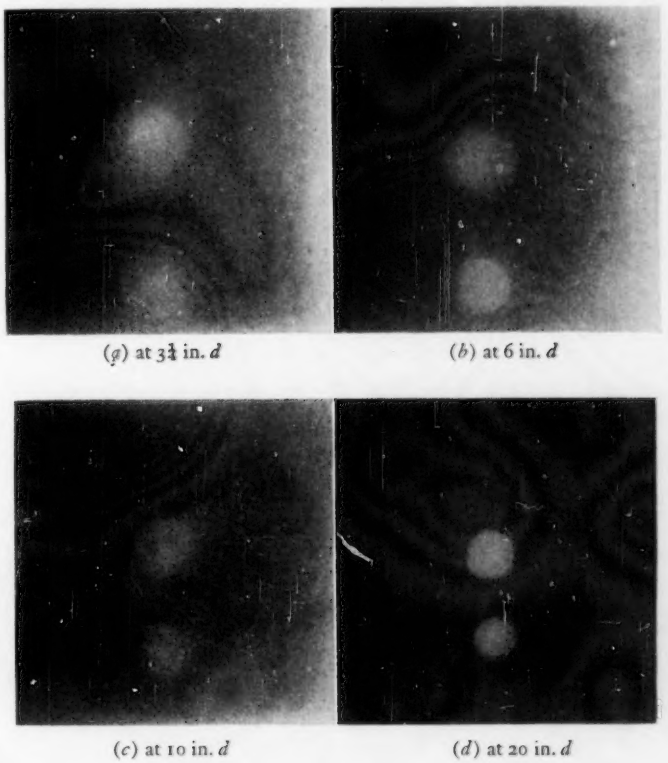


Fig. 1—Eclipse Conditions in Radiography.

Figure 1 shows rays coming from the sun (the source of radiation) and falling upon the moon (the flaw), thus casting a shadow of the moon upon the earth (the film), as in a solar eclipse. The shadow at *A* is a full shadow, that is, an observer standing in the shadow cone *A* could not see any part of the sun (neglecting scattered rays). He would be in total darkness.

But since some of the sun's rays cross each other before they reach the moon, there is a region *C-C* outside the full shadow, called the penumbral region, in which he could see a part of the sun. If he stood near the outer edges of the cone *C-C*, he could see almost the entire surface of the sun. The shadow in which he stood would be faint. If he stood near the axis of the cone, he could see only a thin rim of the sun's area. The shadow would be nearly as intense as the full shadow in *A*.

Thus the shadow intensity in the region *C-C* will fade gradually from a maximum at the edge of the cone *A* to zero at the outermost edge of *C-C*. Outside of *C-C* there will be no shadow at all. This gradual fading of the partial shadow at its edges is illustrated in the radiographs in Fig. 2 (*a*), (*b*), and (*c*). (The "shadow" of a hole is, of course, lighter than the surroundings, while the shadow of the moon is darker.) The partial shadow merges indiscernibly with the full shadow towards the center of the radiograph and just as gradually with the film at its outer edges. This fading results in the inability to measure the diameter of the shadow accurately because its intensity is below visibility at the outer edges. At (*d*) the partial shadow and the full shadow practically coincide.



(*a*) at 3¼ in. *d* (*b*) at 6 in. *d*

(*c*) at 10 in. *d* (*d*) at 20 in. *d*

Fig. 2—Disappearance of Penumbral Haze as Distance, *d*, from Source to Flaw Is Increased.

The region *B* in Fig. 1 is called the "negative shadow." In this region the observer facing the sun will see a constant area of the sun's surface. It is a region of constant intensity of partial shadow. If a point is marked in any one of these shadow areas and lines are drawn tangent to the outer edges of the moon, these shadow relationships will become clear.

The application of these conditions to radiography is as follows:

1. If we know (*a*) the diameter of the sun (radium capsule or cathode spot of the X-ray tube), (*b*) the diameter of the smallest flaw we want to detect, (*c*) the thickness of the metal section, and finally (*d*) the diameter of the smallest shadow we are sure we can detect on the film,

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[2] Gilbert E. Doan and Shang-Shoa Young, "Gamma-Ray Radiography," *Proceedings*, Am. Soc. Testing Mats., Vol. 38, Part II, p. 292 (1938).

then it is a simple problem in geometry to calculate the minimum distance at which the source may be placed from the surface of the object and yet get certain and dependable registry of all flaws in which we are interested. This calculation is made and tested experimentally in a paper by Shang-Shoa Young and the author, which appears in the Society's *Proceedings*, to which the reader is referred.[2] Fig. 3 indicates

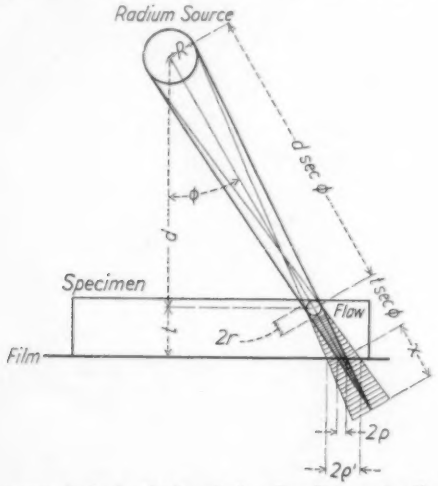

Fig. 3—Geometrical Analysis of the Conditions in Radiographic Testing.

Related to Fig. 3, the formula is as follows:

$$d = \frac{R - r}{r - \rho \cos \phi} t$$

these relationships. Since there are four variables involved, the rule is not a simple one but must be calculated for each case. The calculations are, however, quantitative and our experiments show that they are dependable. They make possible much shorter exposure times than those customarily used. They do not hold, however, for some reason not yet ascertained, when the angle formed between source and flaw is greater than about 10 deg., that is, for very short source-to-film distance, although the flaw-to-film distance must be considered also in using this angle.

The hazy outline of the shadows shown in Fig. 2 is somewhat undesirable in certain instances. It can be avoided by simply increasing the distance from source to flaw, although this will, of course, increase the *time* of exposure as the *square* of the increase in distance. As the distance is increased, the rays coming from the sun become more nearly parallel and the cone *C-C* shrinks, while cone *A* lengthens. At infinite distance, that is with parallel rays, the two cones would coincide. In Fig. 2 (*d*), at 20 in., fairly sharp shadow outlines are obtained. This result requires an included angle of about 2 deg.

2. The other important consideration is the question whether, in a thick specimen, with a short source-to-film distance, that is, with the film at *N* instead of *M* in Fig. 1, we can depend on the *penumbral* shadow *C-C* and the negative shadow *B alone* to register flaws, without recording at all the true shadow *A*. If we can, then thick specimens can be tested using short source-to-object distances, and therefore short exposure times.

The experiments reported in the above paper cover this question also. They show that the full shadow *A* is not necessary at all in recording the presence of flaws. Thus in testing a tube, say 10 in. in diameter, with a wall thickness of say 4 in., it may be possible to put the radium at the center of the cylinder and record flaws on a film wrapped around its circumference without getting any full shadow on the film, thus making the test in much less time than would be possible if rays had to be sent through the entire 8 in. of metal.

As is stated at the beginning of this paper, it is only when small flaws must be detected that these considerations become important. When the flaws are large, larger than the radiant source, then a true shadow will be found at all distances of source-to-film and with specimens of all thicknesses. Thus the desirability of developing small diameter sources of radiation is again emphasized.

Symposium on Temperature

A SYMPOSIUM on "Temperature and its Measurement in Science and Industry" will be held under the auspices of the American Institute of Physics, probably next fall, the dates to be announced later. Consistent with the title, the symposium will broadly cover many fields, its primary purposes according to present plans being to (1) coordinate the treatment of the subject in the sciences and branches of engineering, (2) review principles and bring up to date the record of recent work, (3) accumulate contributions for a comprehensive text, to be published as soon as possible after the symposium is held, (4) reveal the subject as an important branch of physics and (5) supply schools with the information required for the improvement of curricula.

A representative steering committee has been formed, consisting of the Chairman, C. O. Fairchild, Director of Research, C. J. Tagliabue Mfg. Co.; Dr. E. F. DuBois, Medical Director, Russell Sage Institute of Pathology, and Professor of Medicine, Cornell University Medical College; Dr. Gustav Egloff, Director of Research, Universal Oil Products Co.; Dr. John Johnston, Director of Research, U. S. Steel Corporation; Dr. Walter G. Whitman, Head, Department of Chemical Engineering, Massachusetts Institute of Technology, and Dr. H. A. Barton, Director, American Institute of Physics.

Those who are interested in taking part in this symposium should communicate with the Institute, 175 Fifth Ave., New York City, at an early date, giving information regarding their field of work and the subject of the contribution they wish to make. Such contributions will be coordinated with the subjects of a group of invited papers, and assignments and divisions made.

Unique Strength Testing

WE are indebted to *Milwaukee Engineering*, the monthly publication of the Engineers' Society of Milwaukee, for the following: "Testing jaw strength, a Columbia University dental professor found that Eskimos have far more biting strength than college football men."

American Coordinating Committee on Corrosion Formed

A NUMBER of technical societies and other organizations engaged in the study of corrosion have joined in forming the American Coordinating Committee on Corrosion, which is to serve as a clearing house and coordinating agency for information on experience and work in progress in the field of corrosion and corrosion prevention. The Committee was formally organized on February 17 at a meeting held at A.S.T.M. headquarters. The names of the cooperating organizations and their representatives are as follows:

AMERICAN COORDINATING COMMITTEE ON CORROSION

Organization	*Representative*
American Chemical Society	F. N. Speller, National Tube Co., Pittsburgh, Pa.
American Electro-platers' Society	E. A. Anderson, Box 267, Palmerton, Pa.
American Foundrymen's Association	J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
American Gas Association	A. V. Smith, United Gas Improvement Co., 1401 Arch St., Phila., Pa.
American Institute of Chemical Engineers	W. S. Calcott, E. I. du Pont de Nemours and Co., P. O. Box 525, Wilmington, Del.
American Institute of Electrical Engineers	H. S. Phelps, Philadelphia Electric Co., 2301 Market St., Phila., Pa.
American Institute of Mining and Metallurgical Engineers	T. S. Fuller, General Electric Co., Schenectady, N. Y.
American Society of Heating and Ventilating Engineers	A. E. Stacey, Buensod-Stacey Air Conditioning, Inc., 60 E. 42d St., New York City
American Society of Mechanical Engineers	S. Logan Kerr, United Engineers and Constructors, 1401 Arch St., Phila., Pa. Alt.: C. H. Fellows, Detroit Edison Co., Detroit, Mich.
American Society for Metals	T. S. Fuller, General Electric Co., Schenectady, N. Y.
American Society of Refrigerating Engineers	C. Holske, 17 Princeton St., Williston Park, Long Island, N. Y.
American Society for Testing Materials	F. F. Farnsworth, Bell Telephone Labs., New York City
American Water Works Association	W. F. Langelier, University of California, Berkeley, Calif.
Battelle Memorial Institute	H. W. Russell, 505 King Ave., Columbus, Ohio
Electrochemical Society	R. M. Burns, Bell Telephone Labs., New York City
National Bureau of Standards	H. S. Rawdon, National Bureau of Standards, Washington, D. C.
Society of Automotive Engineers	E. H. Dix, Jr., Aluminum Company of America, New Kensington, Pa.
Technical Association of the Pulp and Paper Industry	J. A. Lee, *Chemical and Metallurgical Engineering*, 330 W. 42d St., New York City

The formation of this Committee will, it is expected, meet a need which both individuals and organizations have felt for such a clearing house for information on corrosion work. As its first step the Committee is compiling a list of the names and addresses of those working in the field of corrosion in this country, together with information as to their special interests and their current programs of corrosion studies. To this end the Committee is using the facilities of the various cooperating societies, supplemented by the extensive knowledge of its members on corrosion studies in progress throughout industry. Information is being sought respecting the names of individuals and organizations engaged in corrosion studies, the nature of such studies and a record of experience and publications.

The compilation of such information will serve many useful purposes both to individual workers in the field and to the various technical and industrial organizations that plan and carry out corrosion studies of many different kinds.

It is not the purpose of the Coordinating Committee to abstract the literature on corrosion.

The next meeting of the Committee will be held in June at Atlantic City, N. J., during the A.S.T.M. annual meeting, at which the information thus far compiled will be reviewed, permanent organization effected and the work of the Committee further considered. Pending permanent organization, C. L. Warwick, Secretary-Treasurer of the American Society for Testing Materials, is serving as temporary chairman of the Committee.

NOTICE TO MEMBERS

As may be seen from the announcement on this page of the formation of the American Coordinating Committee on Corrosion, the A.S.T.M. is cooperating with other technical groups in the compilation of what might be termed a Who's Who in Corrosion. One of the immediate aims of the Coordinating Committee is to list the names of investigators in this field and to identify each with those phases of corrosion studies in which he has been most active.

Mr. F. F. Farnsworth, the A.S.T.M. representative on the Coordinating Committee, has undertaken the responsibility of seeing that all A.S.T.M. members who are carrying on corrosion studies, either in their personal capacities or on behalf of their companies or of scientific organizations or technical societies, are included in the lists being compiled by the Coordinating Committee. As his first step he has written to all the members of those committees of the Society carrying on corrosion studies, sending them a form upon which they can report the nature of the work they are doing, whether the results of such work are available, their past experience and publications in this field, and also whether they are interested in exchanging corrosion experience with other corrosion investigators.

There may, however, be a number of investigators in this field who will not be reached through the above-mentioned communication. Accordingly any member of the Society or reader of the ASTM BULLETIN who is engaged in corrosion studies and would like to have his name and work appear in the records of the Coordinating Committee, is invited to communicate promptly with Mr. Farnsworth, who will be glad to supply copies of the form upon which their activities and experience may be noted. Also, members will aid Mr. Farnsworth by bringing to his attention the names of investigators who are not likely to be reached through a canvass of the membership of any of the cooperating societies listed on this page.

Address all communications on the above matter to

Mr. F. F. Farnsworth,
Bell Telephone Laboratories, Inc.,
463 West St.,
New York City.

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No. 97 — March, 1939

Begin Planning Now . . .

BEGINNING Monday, June 26, and extending through Friday, June 30, there will be a series of events at Chalfonte-Haddon Hall, Atlantic City, which should strongly invite the attendance of those concerned with the field of engineering materials. This includes, of course, all members of our Society, but there are a great many other engineers and technologists who for various reasons are not affiliated with A.S.T.M. who would find it of great benefit to attend the Forty-second Annual Meeting and Fifth Exhibit of Testing Apparatus and Related Equipment.

In another portion of the BULLETIN (see page 1) are brief outlines of some of the technical features including round table discussions on metals at low temperatures, quantitative spectrography, and a series of papers on water for industrial uses, soils, and many other papers and reports which will be assembled in a program involving probably some 15 to 20 sessions throughout the five days.

The Fifth Exhibit of Testing Apparatus and Related Equipment (see page 2) will include material that should be of definite interest and in many cases provide helpful suggestions to materials engineers. Those taking part in the Exhibit stress the technical and utilitarian phases of the apparatus. Committee exhibits and research displays add much to the educational atmosphere which is constantly sought.

In connection with the Exhibit, there have been comments on its worthwhileness, but one always stands pre-eminent—namely, the metallurgist who was having his own troubles trying to solve a corrosion problem and who on spending quite a few minutes inspecting the specimen display of Subcommittee VIII on Galvanic and Electrolytic Corrosion of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys, and looking at the annual report showing the data from these tests, remarked in a most appropriate tone, "Boy! There's the answer to my problem hanging on the wall!"

All men (and women, too) are cordially invited to attend the meeting and to take part in it. Discussion of papers and reports is welcomed. There is an opportunity to mingle with outstanding authorities in the field of the Society's work.

It isn't too early to begin planning, thinking of hotel reservations especially, checking into railroad rates or other transportation. 1939 is an exceptional year and plans should be started early. *See you at the annual meeting!*

Not Taxes, But . . .

A NOTE in the *Omaha World Herald* reads "No matter in what direction a tax is hurled, it always hits the ultimate consumer." While it may appear somewhat far-fetched, this thought has a direct parallel when applied to the Society.

Many times we are asked "With what organization are you connected?" When we answer "American Society for Testing Materials" usually there appears on the face of the questioner an expression of bewilderment. Then follows several minutes of explaining as simply as possible just what the A.S.T.M. is and does. As often as not the reaction is "Well that is all very interesting, but what does it do to me," which means a further explanation that while A.S.T.M. standardization and research work may seem to affect only the large producers and consumers of engineering materials, it has a very definite effect on the so-called ultimate consumer.

As a matter of fact there are quite a few A.S.T.M. specifications and tests covering what may be termed ultimate consumer goods that are of direct concern to the small user. But aside from this, the work of the Society over 41 years has undoubtedly had a profound effect on the welfare of the consumer. The standards of quality which are set up become recognized throughout the industry. Hundreds of examples testifying to this fact could be cited. No matter what the material that is the basis of discussion in a standing committee, eventually the benefits from the work that is done there accrue to the ordinary man on the street, regardless of the fact that about 999 out of 1000 are oblivious of the fact that there is such an organization as A.S.T.M. This brings up the question as to what steps should be taken leading toward promotion of information about the Society. It is a fact that while much has been and is being done constantly to promote the knowledge of A.S.T.M., each member can help whenever the appropriate occasion arises to tell something of A.S.T.M.'s purpose and work.

New Committee on Sulfur Cements

THE Executive Committee has recently authorized the formation of a new standing committee, the function of which will be the study of sulfur cements with the development of standard test procedures and purchase specifications. This decision was reached after a conference had been held, under the auspices of Committee E-10 on Standards, of both producers and users to determine the need for work in this field and the feasibility of developing standards.

Sulfur cements are used for a multitude of purposes, the more important of course being that of a jointing material in water and sewer lines, both cast iron and clay, and for various acid-resisting applications. While the Society has long been at work in the field of hydraulic and other cementing materials, sulfur cements did not appear to fall properly in the jurisdiction of any of the existing standing committees, and it is for this reason that a new committee is now contemplated. It is expected that organization will be effected within the next few months.

Several New Sustaining Members

IT is gratifying to note that within the past few weeks six additional companies have become sustaining members of the Society, bringing the total of such members to eighteen compared with the figure of twelve at the close of last year. The six new sustaining members and those who have been designated as their official representatives in the Society are as follows:

Aluminum Company of America, F. C. Frary, Director of Research, New Kensington, Pa.

Bakelite Corp., L. M. Rossi, Vice-President, New York City.

Detroit Edison Co., The, C. F. Hirshfeld, Chief of Research Dept., Detroit, Mich.

Goodrich Co., The B. F., A. W. Carpenter, Manager of Testing Laboratory, Akron, Ohio.

International Nickel Co., Inc., The, R. J. McKay, Chemical Engineer, Nickel Sales Dept., New York City.

Vanadium Corporation of America, Jerome Strauss, Vice-President, Bridgeville, Pa.

In each case the above companies for many years have been affiliated with the Society through company memberships and a number of individuals in the respective organizations have been very active in many phases of the Society's work—participation in technical committee activities; serving on administrative committees; and in other ways.

The twelve companies which had become sustaining members prior to 1939 are as follows:

American Chain and Cable Co., Inc., L. W. Hopkins, Materials Engineer, Bridgeport, Conn.

Atlantic Refining Co., The, T. G. Delbridge, Manager, Research and Development Dept., Philadelphia, Pa.

Bell Telephone Laboratories, Inc., John R. Townsend, Materials Standards Engineer, New York City.

Carnegie-Illinois Steel Corp., C. F. W. Rys, Chief Metallurgical Engineer, Pittsburgh, Pa.

General Motors Corp., F. O. Clements, Technical Director, Research Laboratories, Detroit, Mich.

Inland Steel Co., B. E. Baker, Chief Inspector, East Chicago, Ind.

National Smelting Co., The, Walter M. Weil, Treasurer, Cleveland, Ohio.

Socony-Vacuum Oil Co., Inc., J. B. Rather, In Charge, General Laboratories, New York City.

Sun Oil Co., Arthur E. Pew, Jr., Vice-President, Philadelphia, Pa.

Texas Company, The, M. P. Doss, Librarian, New York City.

Universal Atlas Cement Co., Blaine S. Smith, President, Chicago, Ill.

Western Electric Co., Inc., L. I. Shaw, Development Engineer, Chicago, Ill.

This class of membership was instituted several years ago so that organizations who found it appropriate might contribute to the support of the Society's work to an extent somewhat more commensurate with the real value of A.S.T.M. activities to them. Dues for this type of membership were established at $100 per year. In addition to the many advantages of company membership, including participation in the work of diverse committees by appointing different technical qualified representatives, sustaining members also receive a copy of *all* publications issued by the Society which includes not only those books, pamphlets, reports, etc., furnished members, but also those publications which are available only on purchase. Sustaining members may also request an extra complete set of the Book of Standards without charge.

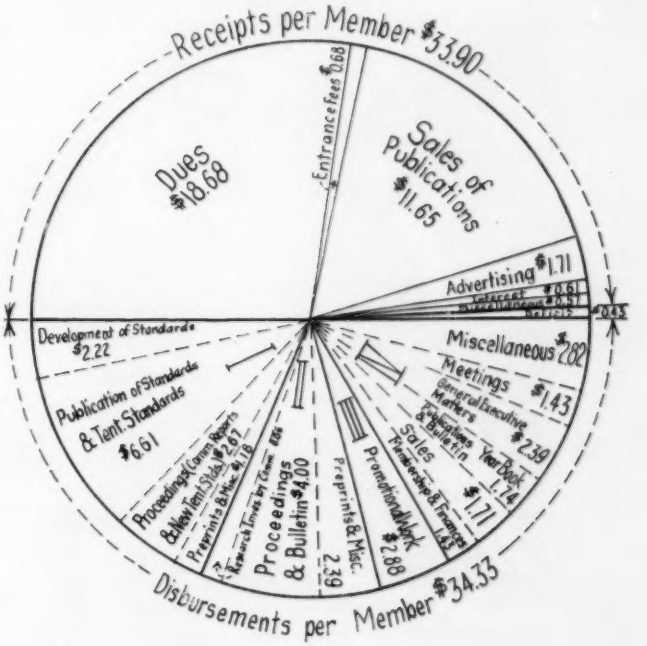
Other organizations who would be interested in obtaining further information and details about sustaining membership are invited to write the Secretary-Treasurer at A.S.T.M. Headquarters.

Notes on Society Finances

THE following notes from the Secretary-Treasurer's report to the Executive Committee in January on finances contain interesting information on 1938 operations.

The total operating (budgeted) receipts for 1938 were $141,032, comprising $80,539 from dues and entrance fees, $48,455 from sales of publications, and $12,038 from advertising, interest and miscellaneous sources. The operating (budgeted) disbursements were $142,818, which includes $6000 reserve towards the cost of the 1939 Book of Standards. Disbursements exceeded receipts by $1786; the deficit was made up from surplus of the preceding year.

An analysis of receipts and disbursements per member appears in the accompanying chart. It will be seen that



receipts from dues are slightly over half of all receipts and that sales of publications are approximately 35 per cent of the total. Disbursements are classified in the following four groups with "per member" amounts as follows:

I. Standardization—Development and Promulgation	$12.68
II. Advancing Knowledge of Materials	7.25
III. Promotional Work	2.88
IV. Administrative Work	11.52
	$34.33

The chart illustrates clearly a fact known to all who are familiar with the financial operations of the Society, namely, the importance of sales of publications as a source of income, supplementing membership dues in making it possible for the Society to serve its members effectively.

The budget which has been set up for 1939 provides for the customary Society activities, including all regular and a number of special publications, and of course takes into account the scheme of financing the combined Book of Standards and Tentative Standards to be issued in November. Detailed announcements of this publication have already been made to the members. The Executive Committee plans to review the income and disbursements quarterly and make any adjustments which seem desirable.

Schedule of Meetings

Date	Committee	Place
March 27, 28	D-12 on Soaps and Other Detergents	New York City
April 3	D-17 on Naval Stores	Baltimore, Md.
During Week of April 3	D-1 on Paint, Varnish Lacquer, and Related Products	Baltimore, Md.
April 4	D-6 on Paper and Paper Products	New York City
April 11	Executive Committee	Philadelphia, Pa.
April 12	C-11 on Gypsum	Washington, D. C.
April 17	D-3 on Gaseous Fuels	Washington, D.C.
April 19	District Meeting	Detroit, Mich.
June 26-30	42nd Annual Meeting and 5th Exhibit	Atlantic City, N. J.

1939 Nominating Committee

AFTER reviewing the report of the tellers, C. A. Rossman, Partner, Philadelphia Thermometer Co., and J. F. Vogdes, Material Engineer, Philadelphia School District, The Board of Public Education, on the recommendations of members for appointments on the 1939 Nominating Committee, the Executive Committee at its January meeting selected members of the committee. A meeting of the Nominating Committee was held in Columbus on March 9 with the following designated members present:

A. W. Carpenter
W. H. Graves
O. L. Moore
H. E. Smith
Jerome Strauss
T. A. Wright

Messrs. Vassar, Fieldner and White were also present as *ex-officio* members of the Nominating Committee in accordance with the By-laws which provide that it shall include the three last past-presidents.

Following the customary procedure, the nominees for president, vice-president and five new members of the Executive Committee will be announced in the May BULLETIN.

Industrial Applications of New Testing Methods to Be Subject of Detroit Meeting on April 19

AT a meeting to be sponsored by the Detroit District Committee at the Detroit Leland Hotel on the evening of April 19 there will be presented four fifteen-minute papers on the general subject "Industrial Applications of New Testing Methods." Four well-known speakers will deliver the papers as follows:

STEELS FOR HIGH-TEMPERATURE SERVICE AND THEIR TESTING—A. E. White, Director of Department of Engineering Research, and Professor of Metallurgical Engineering, University of Michigan.

NEW OIL OXIDATION TESTS CORRELATED WITH SERVICE—H. C. Mougey, Assistant Technical Director and Chief Chemist, Research Laboratories, General Motors Corp.

COLLECTING AND TESTING METHODS OF HEALTH HAZARD MATERIALS—Gordon Harrold, Chief Chemist, Health Laboratory, Chrysler Corp.

MICROSCOPIC AND DROP TEST METHODS ON METALLIC ELECTRO-DEPOSITS—J. W. Higgins, Chief Chemist, Packard Motor Car Co.

Following the custom at recent meetings sponsored by the district committee, there will be a dinner to be followed by the meeting session proper. President T. G. Delbridge and Secretary-Treasurer C. L. Warwick are to be present at the meeting and will speak briefly during the dinner.

The Detroit District Committee extends a cordial welcome to all A.S.T.M. members in the vicinity of Detroit and to all persons interested in the subject matter of the papers to be discussed.

General arrangements for this meeting are in the charge of the Detroit District Committee which consists of 17 active Society members headed by T. A. Boyd, General Motors Corp., chairman, and C. H. Fellows, The Detroit Edison Co., secretary.

District Committee Organized in St. Louis

AT a meeting held in St. Louis, Mo., on January 20, there was consummated a permanent organization of the St. Louis District Committee. Past-President Hermann von Schrenk had been appointed temporary chairman to make arrangements for the meeting and he presided.

The formation of a district committee has been under consideration for some time, and the plans for such a committee were brought nearer to fruition when the Secretary-Treasurer on his return trip from the Pacific Coast in September stopped in St. Louis and held an informal meeting with a number of Society members in the district.

The personnel of the district committee is as follows:

PERSONNEL

ST. LOUIS DISTRICT COMMITTEE

Terms Expiring June, 1940

L. C. Hewitt, Director of Research, Laclede-Christy Clay Products Co., Ambassador Bldg., St. Louis, Mo.
Leroy M. Law, Consulting Asphalt Technologist, Paul Brown Building, St. Louis, Mo.
W. W. Scott, Jr., Vice-President, Laclede Steel Co., Arcade Building, St. Louis, Mo.
L. A. Wagner, Chief Research Chemist, Missouri Portland Cement Co., 9403 Riverview Drive, St. Louis, Mo.

Terms Expiring June, 1941

C. A. Downing, Engineer in Charge, Municipal Testing Laboratory, City of St. Louis.
F. V. Reagel, Engineer of Materials, Missouri State Highway Department, Jefferson City, Mo.
E. O. Sweetser, Professor of Civil Engineering, Washington University, St. Louis, Mo.
Hermann von Schrenk, Consulting Timber Engineer, Tower Grove and Flad Aves., St. Louis, Mo.

Terms Expiring June, 1942

K. R. Fox, Chemical Sales Engineer, Monsanto Chemical Co., 1700 S. Second St., St. Louis, Mo.
G. L. Oliensis, Chemist in Charge, Barber Asphalt Corporation, Madison, Ill.
E. J. Russell, Architect, Mauran, Russell & Crowell, 1620 Chemical Bldg., St. Louis, Mo.
H. E. Wiedemann, Consulting Chemist, Chemical Building, St. Louis, Mo.

The officers chosen were: Chairman, Herman von Schrenk (term expiring June, 1941); Vice-Chairman, E. J. Russell (term expiring June, 1942); and Secretary, L. A. Wagner (term expiring June, 1940).

Many individuals and companies in the St. Louis area are affiliated with the Society, quite a number taking an active part in committee and related work. This new district committee will provide a means of advancing the interests of the Society in this locality and furthering the purposes for which the Society is organized.

Including St. Louis, there are now nine district committees as follows: Chicago, Cleveland, Detroit, New York, Northern California, Philadelphia, Pittsburgh, St. Louis, and Southern California.

Specifications for Gypsum Plastering and Lathing Issued

THE American Standard Specifications for Gypsum Plastering, Including Requirements for Lathing and Furring, developed by Sectional Committee A-42 on Specifications for Plastering and approved as an "American Standard" by the American Standards Association, have recently become available.

It is interesting to note that these specifications represent the culmination, in part at least, of proposals originating some 19 years ago in A.S.T.M. Committee C-11 on Gypsum. Specifications for gypsum plasters proposed at that time by Committee C-11 included requirements for application, workmanship and recommended practices for plastering. The specifications were published in the 1919 A.S.T.M. *Proceedings* under the title "Tentative Report on Gypsum Plasters." In view of the design and construction features, the specifications were not deemed appropriate for adoption by the Society.

The subject of specifications for plastering was held in abeyance until 1927 when Committee C-7 on Lime expressed an interest in having specifications for lime plastering prepared. Accordingly, in 1930, Sectional Committee A-42 was organized with the American Concrete Institute and the A.S.T.M. as sponsor organizations.

The first draft of a proposed specification covering all types of plastering and lathing was issued by the committee in December, 1933; the second in February, 1935. The sectional committee subsequently decided to subdivide the proposed standard into individual specifications for the various types of plastering (gypsum, lime, portland cement) and for lathing. The specifications for gypsum plastering and lathing were nearest completion, and after the circularization of various drafts, the specifications for gypsum plastering and lathing were endorsed by the sectional committee for submission to the sponsors for approval by the American Standards Association.

The American Standard is divided into two chapters, which cover the following topics:

CHAPTER I ON GYPSUM PLASTERING

General Provisions	Mechanical Mixing
Description of Terms	Finish Coat Proportions
Scope of Work	Thickness of Plaster
Materials	Preparations for Plastering
Base Coat Proportions	Application of Base Coats
Hand Mixing	Application of Finishes

CHAPTER II ON LATHING AND FURRING

Materials	Application of Metal Lath, Wire Lath, and Wire Fabric
Lathing	Metal Ceiling Construction
Application of Gypsum Lath	Steel Studs for Solid Plaster Partitions
Application of Wood Lath	Metal Wall Furring
Application of Fiber Insulation Lath	Workmanship

The materials used for gypsum plastering and lathing are required to meet the requirements of seven designated A.S.T.M. standard specifications. These include the Tentative Specifications for Sand for Use in Plaster (C 35 - 36 T) which for convenience of reference are appended to the American Standard as finally published.

In the short time that the specifications have been available they have been given a wide distribution to architects, engineers, building officials, plastering contractors, and lathers and plasterers throughout the country in order that the specifications will be available to all those concerned with gypsum plastering and lathing.

Copies of the American Standard can be obtained from American Standards Association, 29 W. 39th St., New York City, and from the A.S.T.M., 260 S. Broad St., Philadelphia, at 25 cents per copy.

Methods of Sampling Ferro-Alloys Revised

NEW Tentative Methods of Sampling Ferro-Alloys (E 32 – 39 T) were issued by the Society on March 4 following their acceptance for publication by Committee E-10 on Standards. These methods represent a revision of and replace the former Tentative Methods of Sampling Ferro-Alloys (A 103 – 36 T).

The new methods were accepted on the recommendation of Committee E-3 on Chemical Analysis of Metals (G. E. F. Lundell, chairman) under whose jurisdiction they have been developed. Subcommittee C-1, under the chairmanship of Dr. C. B. Francis, Carnegie-Illinois Steel Corp., of the E-3 Division C on Sampling (T. A. Wright, chairman), made an extensive survey of sampling procedures in current industrial use. The information obtained by this study was used by the committee as a basis for the revised methods which include a number of improvements for obtaining representative quantities of ferro-alloys for complete chemical analysis. The methods are applicable to the sampling of some 20 grades or types of ferro-alloys either before shipment from the place of manufacture or after delivery to the purchaser.

The new sampling procedures are companion methods to the Tentative Methods of Chemical Analysis of Ferro-Alloys (E 31 – 38 T) which were accepted by the Society on August 25 through Committee E-10. The issuance of these two methods brings up to date the A.S.T.M. standards for ferro-alloys as the existing nine specifications were revised last June by Committee A-9 on Ferro-Alloys.

These methods of sampling and chemical analysis of ferro-alloys will be published shortly as supplements to the volume of "A.S.T.M. Methods of Chemical Analysis of Metals (1936)." A copy of these supplements will be sent to those members who have requested them. Extra copies of each are available at 25 cents.

Committee on Concrete Establishes Sanford E. Thompson Award

THERE has just been established by Committee C-9 on Concrete and Concrete Aggregates the Sanford E. Thompson Award to be made annually to the author or authors of a paper of outstanding merit on concrete or concrete aggregates presented at the preceding annual meeting of the Society. The award is named in honor of the first chairman of the committee. The purposes are to stimulate research, encourage the presentation of results of investigations that extend the knowledge of concrete and concrete aggregates, and to recognize meritorious efforts.

Under the rules governing the award, Committee C-9 will appoint annually a committee consisting of three members to review the papers that may be eligible. The award is to be made at one of the sessions on concrete. It will take the form of an honorarium of $50 with a suitable certificate. The general rules are in the authority of the C-9 advisory committee.

Aggregate for Masonry Mortar

Report of Subcommittee IV of A. S. T. M. Committee C-12 on Mortars for Unit Masonry

NOTE: This report was submitted to letter ballot of the subcommittee consisting of six members of whom five voted affirmatively and one failed to return the ballot. It was also circulated to all members of Committee C-12 and was considered by the committee at its meeting in Columbus on March 10, 1939. Its recommendations were accepted by the committee subject to letter ballot. A favorable letter ballot will lead to the recommendation to the Society at the forthcoming annual meeting that the proposed specifications be published as tentative.

SUBCOMMITTEE IV on Aggregate for Masonry Mortar, charged with the duty of drafting specifications for aggregate for masonry mortar, submitted a comprehensive progress report to Committee C-12 at its meeting in Washington, D. C., on November 2, 1938. That report was based on extensive correspondence, on one regularly called meeting of the subcommittee and on several informal meetings of various members of the subcommittee. As a result of that work and of subsequent correspondence, Subcommittee IV now presents, for action by Committee C-12, proposed specifications which are the same as submitted with the progress report at the meeting on November 2.

Before discussing the proposed specifications it should be of interest to outline the considerations which led to their development. A first draft was submitted to the subcommittee on August 17, 1938. That led to active correspondence and it was immediately evident that there would be no difficulty in reaching agreement on all phases, except grading—and many differences of opinion developed on that score. The grading initially proposed was a conventional one, shown in Table I.

TABLE I.

Sieve	*Percentages by Weight Passing Each Sieve*	
	Minimum	*Maximum*
No. 8	100	...
No. 16	65	90
No. 30	35	70
No. 50	15	40
No. 100	0	10

Objections to the proposed grading limits were received promptly. One member of the subcommittee pointed out that they would bar from use some stone sands, containing large percentages of dust, which have been used with success. He gave the grading shown in Table II as an example of a "notably successful" material when used in "straight" portland-cement mortar.

TABLE II.

Sieve	*Percentages by Weight Passing Each Sieve*
No. 4	100
No. 8	93
No. 16	56
No. 30	40
No. 50	33
No. 100	29
No. 200	26

Another member of the subcommittee objected to the grading limits because they would permit, technically, the use of a material with a high proportion of one size. For example, as much as 55 per cent of either the No. 50 to No. 30 size or the No. 30 to No. 16 size might occur. He discussed objections to "humps" in the grading curve and cited the grading shown in Table III as approximating an "ideal."

His analysis of studies of stucco had indicated to him that best results were obtained with about 15 per cent or more passing a No. 100 sieve. He suggested fixing grading limits consistent with the "ideal," shown in Table III, with the further restriction that an aggregate have no more than 30 per cent of its particles retained between adjacent sieves in the series beginning with No. 200 and increasing in clear opening in the ratio of two. Later, he modified that suggestion to provide for a sliding scale of limitations on individual "sieve fractions."

TABLE III.

Sieve	*Percentages by Weight Passing Each Sieve*
No. 12	100
No. 16	83
No. 30	56
No. 50	32
No. 100	13
No. 200	4

A third member of the subcommittee commented, in substance, as follows:

"Both the limits on grading in the draft of August 17 and the discussions from members of the subcommittee recognize the desirability of having a larger proportion of fine particles in aggregates for mortars than for the mortar component of concrete. The chief reasons are: (1) the ratio of cement to fine aggregate in concrete usually is greater than for masonry mortars, and the fine particles of the cementing material in concrete mixtures tend to supplement any deficiencies in the amount of fine materials in the aggregates; (2) the maximum size of fine aggregate for concrete usually is larger than for mortar aggregates and thus a smaller percentage of the finer particles is required for equal workability; (3) strength is of prime consideration in concrete, whereas, for mortars it is secondary to workability; (4) concrete mixtures, especially those used in pavements and floors, are well compacted after placing, whereas, mortars receive but little compaction and, therefore, must have such properties as will permit satisfactory placement with little manipulation.

"Although the need for relatively large proportions of fine particles is recognized, the desirability of having the amount of them vary with the size of the largest particles apparently has been overlooked in specifications. The maximum size of aggregates for mortars should depend upon the use of the mortars and vary with the thickness of the joints in the masonry. For joints of a given thickness there is some advantage in using aggregates of the largest maximum size compatible with satisfactory workmanship. That tends to result in an economy in the use of cement and in a minimum volume change of the hardened mortar. However, it is not economical to exclude aggregates of suitable grading when they are either unusually coarse or unusually fine, if they are the only ones available at a low cost.

"In view of the foregoing, it seems that if the limits on grading are so broad as to include suitable aggregates for most uses they will not exclude poorly graded materials. A single set of grading limits, therefore, cannot be satisfactory unless supplemented by additional restrictions on grading. Perhaps the simplest way to provide for the acceptance of aggregates of suitable grading and at the same time to specify limits on grading which will reject those of poor grading is to have more than one set of limits. Then the grading limits would be in a form familiar to purchasers and sellers and no computations would be required to determine whether or not a particular aggregate meets the requirements. For example, there could be four sets of limits, each of which would define a material of suitable grading, and each differing from all of the rest in the proportions required to lie between two successive sieves. This form of specification is illustrated in Table IV, the values of the grading limits being, incidentally, for materials having substantially geometrically similar particle size distributions after additions of a cement in commonly used proportions":

TABLE IV.

Percentages by Weight Passing Each Sieve

Sieve	*Grading 1*	*Grading 2*	*Grading 3*	*Grading 4*
No. 4	100			
No. 8	90 to 100	100	100	100
No. 16	50 to 70	60 to 80	70 to 90	80 to 100
No. 30	30 to 50	35 to 55	45 to 65	55 to 75
No. 50	15 to 30	20 to 35	25 to 40	30 to 45
No. 100	5 to 15	10 to 20	15 to 25	20 to 30
No. 200[1]	0 to 5	0 to 10	0 to 10	5 to 15

[1] Removed by washing.

Other members of the committee recognized the merit of the objectives of the several suggestions. However, they questioned, in varying degrees, the practicability of attaining those objectives by the procedures outlined. Their individual comments may be summarized, fairly it is believed, as follows:

1. The permissibility of relatively high proportions of stone dust in stone sands, used under many circumstances, was admitted. It was pointed out, however, that grading limits which would permit the use of the material illustrated in Table II, and at the same time admit other entirely suitable materials, would be so wide as to be meaningless. It was also felt that unqualified admission of material with such high percentages of fines would result in poor workmanship under many circumstances.

2. With respect to the proposed maximum for the amount in any "sieve fraction" it was pointed out that a high proportion of widely and successfully used aggregates would fail to meet the proposed limitation. The belief was also expressed that a limitation of that nature, stringent enough to be significant, would unduly complicate the interpretation of specifications.

3. With respect to the suggestion that relatively high proportions of materials finer than a No. 100 and a No. 200 sieve be required, attention was directed to the impracticability, often impossibility, of producing natural sand to meet such requirements. It was proposed that, if such high proportions of the finer sizes were essential, provision be made for obtaining them by the addition of an independent material—stone dust, for example.

4. With respect to the four grading limits shown in Table IV, the question was raised as to the feasibility of obtaining aggregates, economically produced, to meet them and as to the necessity for such comparatively narrow limits.

All of the recommendations which have been outlined in the preceding paragraphs were carefully reviewed by a special subcommittee, consisting of Messrs. D. E. Parsons, A. T. Goldbeck and Stanton Walker, appointed for that purpose. After most earnest consideration, the special subcommittee arrived at the conclusion that it was not practicable, at this time, to propose a well-defined recommendation for grading of aggregate for masonry mortar but that instead (for the time being, at least, and perhaps permanently) the specification should be restricted to a statement of the fundamentally desirable characteristics with respect to grading.

Based on that thought, the appended specifications are submitted to Committee C-12, with the recommendation that they be presented to the Society for publication as tentative. These specifications are in conventional form except as to the grading requirements. Instead of specific limits, recommended practices to guide the engineer in preparing a purchase specification for aggregates are outlined.

Respectfully submitted in behalf of the subcommittee,

STANTON WALKER, *Chairman.*

Proposed Specifications for Aggregate for Masonry Mortar[1]

Scope

1. These specifications cover aggregates for use in masonry mortar.

Material

2. Aggregate for use in masonry mortar shall consist of fine granular material composed of hard, strong, durable mineral particles which are free from injurious amounts of saline, alkaline, organic, or other deleterious substances.

Grading

Aggregate for use in masonry mortar shall be uniformly graded from fine to coarse within the limits specified by the engineer.

IMPORTANT NOTE—The committee has found that sands of such widely different gradings have given satisfactory results in masonry motar, depending upon the type of construction and the characteristics of the cementing material, that it has not attempted, at this time, to outline specific recommendations for grading. To do so would result in, on the one hand, limits so broad as to be meaningless or, on the other hand, limits so narrow as to prohibit the use of many materials which have been found to be satisfactory. Accordingly, the committee restricts its recommendations to the following outline of certain fundamental principles:

(*a*) The aggregate should be well graded and contain sufficient of the finer sizes to provide a suitable degree of workability. Unduly fine aggregates should be avoided since they require the use of excessive quantities of mixing water or excessive quantities of cementing materials. In general, the use of an aggregate finer than one which is well graded up to a No. 16 sieve should be avoided.

(*b*) The maximum size of the aggregate should not exceed that consistent with the type of construction. The following limits are suggested:

Type of Masonry Construction	*Maximum Size of Aggregate* [a]
Joints ½ in. or thicker	No. 4 sieve [b]
Joints of average thickness (such as for brick masonry)	No. 8 sieve [b]
Thin joints for units having cut or ground edges	No. 16 sieve [b]

[a] A smaller maximum size may be used.

[b] A permissible variation of at least 5 per cent of material retained on the sieves designated as the maximum size should be permitted.

(*c*) The aggregate should contain a substantial proportion of material finer than a No. 50 sieve, although excessive quantities should be avoided. The following limits are recommended:

Maximum Size	*Percentage Passing No. 50 Sieve*
No. 4 sieve	10 to 30
No. 8 sieve	15 to 35
No. 16 sieve	20 to 40

(*d*) To fill the gap which usually exists between the coarser particles in the cementing material and the No. 100 sieve size, it is desirable that some proportion of the aggregate, generally (but with possible exceptions) not to exceed about 20 per cent, be finer than the No. 100 sieve. Most washed natural sands contain relatively little material finer than the No. 100 sieve, and it is sometimes desirable to supply such finer sizes by blending with a second, and finer, aggregate. Aggregates containing sufficient material finer than the No. 100 sieve should be examined carefully to determine whether the fine material is of suitable mineralogical composition.

(*e*) The grading characteristics of the material available in the locality in which the work is to be done should be taken into ac-

[1] Under the standardization procedure of the Society, these proposed specifications are under the jurisdiction of the A.S.T.M. Committee C-12 on Mortars for Unit Masonry.

count by the engineer. In order to insure a reasonable degree of uniformity in the aggregate for a given project the requirements should be so specified that *ranges* in the percentages of material *passing* the various sieves do not exceed the following:

	Recommended Permissible Range in Percentages Passing Each Sieve		
Sieve Size	*Max. Size No. 4 Sieve*	*Max. Size No. 8 Sieve*	*Max. Size No. 16 Sieve*
No. 3	0	...	...
No. 4	5	0	...
No. 8	15	5	0
No. 16	20	20	5
No. 30	30	30	25
No. 50	20	20	20
No. 100	10	10	10
No. 200	5	5	5

(*f*) The percentages in the preceding table must not be confused with percentages passing or retained on the various sieves. *The values given are ranges.* For example, the following specification for grading of a fine aggregate with a maximum size of No. 16 (not given as a recommendation, but for illustration only) conforms to the recommendations in the preceding tabulation:

Sieve Size	*Percentages Passing Each Sieve*
No. 8	100
No. 16	95 to 100
No. 30	60 to 85
No. 50	20 to 40
No. 100	0 to 10
No. 200	0 to 5

Deleterious Substances

4. *(a)* The amount of deleterious substances shall not exceed the following:

	Maximum Permissible Percentage by Weight
Coal and lignite	0.25
Clay lumps	1
Shale, alkali, coated grains, soft or flaky particles	1
Other deleterious substances	...
Total deleterious substances	3

(b) Aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless it shall pass the mortar strength test as specified in Section 5.

Mortar Strength Test

5. Aggregate shall be of such quality when subjected to the mortar strength test that it shall have a compressive strength at ages of 7 and 28 days of not less than 95 per cent of that developed by a mortar of the same water-cement-ratio and consistency made with the same cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.

Methods of Testing

6. The properties enumerated in these specifications shall be determined in accordance with the following methods of test of the American Society for Testing Materials:

(a) Sieve Analysis.—Tentative Method of Test for Sieve Analysis of Fine and Coarse Aggregates (A.S.T.M. Designation: C 136).[2]

(b) Washing Test.—Standard Method of Test for Determination of Amount of Material Finer than No. 200 Sieve in Aggregates (A.S.T.M. Designation: C 117).[3]

(c) Coal and Lignite.—Tentative Method of Test for Coal and Lignite in Sand (A.S.T.M. Designation: C 123).[4]

(d) Clay Lumps.—Tentative Method of Test for Clay Lumps in Aggregate (A.S.T.M. Designation: C 142).[2]

(e) Organic Impurities.—Standard Method of Test for Organic Impurities in Sands for Concrete (A.S.T.M. Designation: C 40).[5]

(f) Mortar Strength.—Standard Method of Test for Structural Strength of Fine Aggregate Using Constant Water-Cement-Ratio Mortar (A.S.T.M. Designation: C 87).[5]

[2] *Proceedings,* Am. Soc. Testing Mats., Vol. 38, Part I, pp. 808, 806 (1938); also 1938 Book of A.S.T.M. Tentative Standards, pp. 636, 632.
[3] 1937 Supplement to Book of A.S.T.M. Standards, p. 99.
[4] *Proceedings,* Am. Soc. Testing Mats., Vol. 36, Part I, p. 794 (1936); also 1938 Book of A.S.T.M. Tentative Standards, p. 634.
[5] 1936 Book of A.S.T.M. Standards, Part II, pp. 380, 355.

Foreign Standards Recently Issued

STANDARDS issued by a number of engineering and technical organizations in foreign countries are received by the Society as they are adopted or revised. Since members of the Society may be interested in knowing that such standards are available they will be listed as received in the A.S.T.M. BULLETIN.

Recently the following standards have been issued:

AUSTRALIAN STANDARD SPECIFICATIONS FOR:

Residual Bitumen and Fluxed Native Asphalt for Road-making Purposes (No. A. 10—1938).

Dimensions of Rivets from $\frac{1}{2}$ in. to $1\frac{3}{4}$ in. diameter (No. A. 34—1938).

Round Strand Steel Wire Ropes for Cranes and Hoists (No. B. 9—1938).

Carbon Steel Forgings (Primarily for Cranes and Hoists) (No. B. 63—1938).

S.A.A. Crane and Hoist Code (CB. 2—1938).

Chemical Lead (No. H. 10—1938).

Australian Standard Glossary of Terms Used in Road Engineering (No. A. 16—1938).

FRENCH STANDARDS ASSOCIATION (AIR DEPARTMENT):

Standard Methods for Wood, including tests for dimensions, specific gravity, compression, static bending, dynamic bending, splitting, retraction, and transverse section (AIR Nos. 0610 to 0618).

ITALIAN STANDARDS FOR:

Tests on Metallic Materials (551 to 565).

Nut Fittings for Extra Light Pipes (566 to 602).

Ball and Roller Bearings (603 to 659).

Rods for Aircraft (660 to 661).

Control Cable Pulleys for Aircraft (662).

BRITISH STANDARD SPECIFICATIONS FOR:

Aluminum (Powder and Paste) for Paints (No. 388—1938).

Lead Chromes and Zinc Chromes for Paints (Nos. 282 and 389—1938).

Oil Pastes for Paints (No. 390—1938).

Pipe Threads (Basic Sizes and Tolerances) (No. 21—1938).

BRITISH STANDARD SPECIFICATIONS FOR:

Rubber-Insulated Cables and Flexible Cords for Electric Power and Lighting (No. 7—1939).

Steel Tubular Traction Poles (No. 8—1939).

Tensile Testing of Metals (No. 18—1938).

Malleable Cast Iron and Cast Copper Alloy Pipe Fittings (Screwed B.S.P. Taper Thread) for Steam, Water, Gas and Oil (No. 143—1938).

Electric Power Switchgear for Indoor and Outdoor Installations Up to and Including 220,000 volts (No. 162—1938).

Cast Iron Straightedges (Grades A and B) (No. 818—1938).

Grey Cast-Iron Conduit Boxes for Electrical Wiring (No. 820—1938).

Iron Castings for Gears and Gear Blanks (Ordinary, Medium and High Grades) (No. 821—1938).

Steel Storage Bins and Racks (No. 826—1939).

Committee Week

Activities Summarized

(Continued from page 10)

will probably deal with electroplated coatings on non-ferrous metals.

A recommendation will be made that the Society publish a paper by Doctor Borgmann on "The Results of Atmospheric Corrosion Tests Carried Out by Subcommittee VI on Atmospheric Corrosion." This paper gives the author's personal interpretation of these results which were published in the 1938 ASTM *Proceedings* as part of the yearly report of the committee.

Committee B-5 on Copper and Copper Alloys, Cast and Wrought

During the past year this committee had reorganized its internal subcommittee structure by organizing ten subdivisions, each of which was made responsible for different types of copper and copper-alloy cast, wrought and fabricated products. With the development of new alloys and the increasing use of the materials under the jurisdiction of the committee, it was necessary to enlarge the committee and subdivide its work.

New specifications for leaded brass sheet and strip were approved for submission to the Society. Revisions are being proposed in the tentative specifications for sheet and strip phosphor bronze (B 103) to provide for the addition of a new alloy of leaded phosphor bronze. New specifications for copper-nickel zinc and copper-nickel sheet and strip were also presented.

In the field of miscellaneous copper base wrought alloys there was reported the completion of new specifications for beryllium-copper which will include requirements for sheet, strip, wire and rod. The adoption as standard of existing tentative specifications for copper-silicon alloy plates and sheets (B 96) and sheet copper-silicon alloy (B 97) is being recommended. The two companion specifications which cover respectively copper-silicon alloy rods, bars and shapes (B 98) and copper-silicon alloy wire for general purposes (B 99) were also recommended for adoption. Revisions were approved for immediate adoption in the standard specifications for naval brass rods for structural purposes (B 21).

Extensive revisions were developed in the specifications for copper pipe, standard sizes (B 42) and due to the nature of the changes the revised specifications will be published as tentative. The standard specifications for seamless copper tubing, bright and annealed (B 68) are to be changed at several points and published as tentative. The committee also decided to revise the specifications for seamless copper tubes (B 75) to include material now covered in specifications for seamless copper boiler tubes (B 13) which will be discontinued. Important revisions were approved for immediate adoption in the specifications for copper water tube (B 88).

It was announced that after detailed consideration extensive changes had been completed in the specifications for brass pipe, standard sizes (B 43), the specifications as revised to be recommended for publication as tentative. In preparation are specifications for miscellaneous brass tubing.

New tentative specifications for copper and copper alloy forging rod were presented for publication to replace the existing specifications for brass forging rod (B 15), the latter to be withdrawn.

Tentative revisions (published last year) of the specifications for manganese-bronze ingots for sand castings (B 7) and for manganese-bronze sand castings (B 54) were recommended for adoption in the specifications this year and a new revision was approved to provide for the inclusion in these two standards of requirements for a high tensile strength manganese-bronze alloy. The subcommittee in charge presented new specifications for nickel-silver casting alloys which will cover four alloy compositions or grades.

In order to simplify the preparation of specifications for the many copper-base casting alloys, consideration has been given to the establishment of a classification or appropriate nomenclature for the groups of alloys. This has resulted in the writing of a classification of the cast copper-base alloys for foundry purposes, recommended for publication as tentative this year.

A new subcommittee has been appointed to consider questions dealing with methods of testing copper and copper alloys. This group will review the present practices for tension testing of strip materials in their original fabricated form before machining. The question of thickness measurements is also quite important for various copper products, particularly tubing and sheet and strip and plate materials. A study is planned of procedures for the micrometer measurements of such materials. The committee is also planning to study the tapered pin method for testing copper tubing.

Committee B-6 on Die Cast Metals and Alloys

The group in charge of work on tin- and lead-base die casting alloys is recommending a change in the tin and copper contents of alloy No. 2 in the specifications for lead and tin-base alloy die castings (B 102) to provide an increased range of 80 to 84 per cent tin and 4 to 6 per cent copper, respectively.

Through the cooperation of the Madison-Kipp Corp. the committee has available samples of the five lead- and tin-base alloys. These are to be tested for tensile strength by three laboratories and creep tests on the specimens will be run by two laboratories. The samples will be analyzed spectrographically by several cooperating laboratories.

In connection with the work of Subcommittee IV on Physical Tests of Die Castings there was discussion on speed and temperature of tension testing and the length of the impact test bar. A letter ballot on these matters is being canvassed to elicit the views of various interests with the results to be reported at the June meeting.

The subcommittee on exposure and corrosion tests has completed tests on all of the zinc alloys on the test racks with the exception of alloy No. 21, and data on these tests will be included in the 1939 annual report. Alloy No. 21, which includes a copper content of 2.5 to 3.5 per cent, aluminum 3.5 to 4.5 per cent, and the several alumium alloys included in the tests are to be continued for at least five years more so that the total time on exposure will be at least 15 years. These corrosion tests have been under way in various

parts of the country and several reports have been published by the Society.

The committee expects to start exposure tests this year on new zinc and magnesium alloys, tests for physical properties and analyses have been made, and the data submitted to the committee. In the specifications for magnesium-base alloy die castings (B 94) one new alloy designated as "13" has been proposed with the following suggested composition: Aluminum, 8.3 to 9.7 per cent; Manganese, 0.013 min.; Zinc, 0.4-1.0; Silicon, 0.5 max.; Copper, 0.05 max.; Nickel, 0.03 max.; Other (Cadmium and Tin), 0.3 max.; Balance, Magnesium.

Committee B-7 on Light Metals and Alloys

Several significant actions were taken by Committee B-7 including revisions that are recommended in two existing standards covering aluminum ingots for remelting and aluminum for use in the manufacture of iron and steel. These are to be reissued as tentative specifications. The latter was developed with the cooperation of a number of steel technologists acting in an advisory capacity.

A new specification will be issued covering aluminum-base alloys in ingot form for die castings. The existing tentative requirements for magnesium ingot and stick for remelting (B 92) are to be balloted on for adoption as standard.

In addition, revisions have been proposed in several existing specifications as follows: (1) aluminum-base alloy in ingot form for sand castings (B 58), and for permanent mold castings (B 112) (to limit analysis to elements listed unless the presence of others is indicated in routine analysis); (2) aluminum-alloy sheet and plate (B 78), and aluminum bars, rods and shapes (B 89) (revise limits on sizes, source of material and mechanical properties to conform to present commercial practice); (3) aluminum-magnesium-chromium sheet and plate (B 109) (add requirements for intermediate temper material and revise requirements with respect to source of material); (4) magnesium base alloy ingot for remelting (B 93) (add another die-casting alloy with composition conforming to limits selected by Committee B-6 on Die-Cast Metals and Alloys).

Other significant items of business included a report by the subcommittee on testing that all aluminum and magnesium alloy specimens for inclusion in the speed of testing investigation being carried out by Committee E-1 have been prepared and turned over to that committee. Another report indicated that work on methods of testing anodic coatings was progressing. Methods of determining the abrasion resistance of such coatings are being given further attention and a report on this work is expected for the June meeting of B-7. A method of testing the scaling characteristics of such coatings and an indirect method of determining coating thickness by the weight of oxide on a given area are also being investigated.

Committee E-2 on Spectrographic Analysis

Committee E-2 on Spectographic Analysis met at Columbus, Ohio, during A.S.T.M. Committee Week, March 6 to 10, inclusive. Plans were considered for a Symposium on Fundamental Methods and Technique of Spectographic Analysis. The committee anticipates having two and possibly three sessions of a round table nature at the annual meeting of the Society this year; this discussion would be condensed and correlated by the E-2 Subcommittee on Fundamental Methods and Technique with the expectation that based thereon a more formal symposium will be held a year hence.

The committee plans to continue its three existing methods of quantitative spectrochemical analysis (high-grade pig lead (E 25); zinc for lead, iron and cadmium (E 26); and zinc alloy die castings (E 27)); but certain revisions and procedures are to be studied during the year.

It was announced that considerable interest had been shown in the publication "Index to the Literature on Spectrochemical Analysis," sponsored by the committee during the past year, the Index having been prepared by William F. Meggers and Bourdon F. Scribner, of the National Bureau of Standards.

Committee C-1 on Cement

Subject to letter ballot it will be recommended that the final setting time requirement be eliminated from the present standard specifications for high-early-strength portland cement (C 74). No other action affecting existing standards was taken. However, approval was given to two alternate methods for the determination of free calcium oxide in portland cement and clinker for inclusion in the tentative methods of chemical analysis of portland cement (C 114). A new method for determining the specific gravity of cement was also accepted. These methods will be recommended to the Society after a letter ballot is canvassed.

The chairman was instructed to appoint a committee to formulate plans which would insure placing before Committee C-1, at some future meeting, carefully assembled presentation of data and thoughts on two subjects, namely, the status of specifications for portland cement and additions to cement.

Active progress was reported on studies of volume change, compression test studies of plastic mortars and investigation of chemical methods. Study was also reported as in progress on water retention tests, testing sands, questions pertaining to requirements for low-heat cements, results of tests on blended cements, and masonry cement specifications.

Considerable time was devoted to the discussion of details of the results of the chemical and physical determinations reported by the 161 laboratories which participated in the recent tests of comparative sample No. 2, which sample had been distributed by the Cement Reference Laboratory at the National Bureau of Standards. It was decided that the Reference Laboratory, which is a cooperative project of the National Bureau of Standards and the American Society for Testing Materials, and is sponsored by Committee C-1, should continue these comparative tests at stated intervals.

Committee C-7 on Lime

Following its extensive Symposium on Lime held as part of the 1939 A.S.T.M. Regional Meeting, Committee C-7 met on Thursday. The symposium, comprising eleven papers, covered various phases of tests and properties of lime and lime products, the papers presenting information and data from the standpoint of both research and experience. The symposium was the result of activity of C-7's subgroup on research.

The subcommittee on lime for the chemical industries re-

ported continuation of cooperation with the Technical Association of the Pulp and Paper Industry, especially on the matter of the increasing use of slow-setting magnesium lime products for utilizing so-called sludge from soda ash causticizing as paper filler. It was pointed out that this work was not merely a research idea, but it has been set up as a chemical engineering manufacturing procedure for several years.

The committee accepted the joint committee report regarding sand specifications to the effect that the loophole be closed which permitted the presence of 5 per cent saline matter and organic matter.

The committee plans to study further suggested revisions of the specifications for lime for silica brick and to investigate the possibility of combining into one specification requirements for hydrated and quicklimes for water softening.

There was extended discussion at the meeting in connection with the work of the subcommittee on nomenclature and definitions. Doctor Fippin of the Tennessee Valley Authority outlined misunderstandings in the agricultural fields and the conflicting interests on this matter. The thought was expressed that if Committee C-7 could reach a proper definition of lime (on which subject the subcommittee on definitions submitted a voluminous report) as distinguished from natural stone products, this confusion of many years' standing might be alleviated.

Committee C-8 on Refractories

During the past year the subcommittee on industrial surveys has prepared two new surveys, the first entitled "Conditions Surrounding Refractories Service in Continuous Plant and Window Glass Furnaces" and the second, "Industrial Survey of Conditions Surrounding Refractory Service in Lime Burning." They have both been approved by letter ballot of the committee and will be included in the annual report to be presented at the 1939 annual meeting, June 26 to 30. These two new surveys will thus supplement others covering open-hearth practice, malleable iron industry, copper industry, lead industry, by-product coke ovens and the glass industry as it pertains to continuous bottle furnaces.

Action was taken to submit to letter ballot for adoption as standard several tentative specifications and tests. These include the test for cold crushing strength and modulus of rupture (C 133), the tentative standard (C 18) which covers methods of chemical analysis of refractory materials, and also the definitions of 50, 60, and 70 per cent alumina-diaspore refractories which are covered in definitions of terms relating to refractories (C 71 – 37 T).

The committee has been working for some time on revised procedures for testing high-temperature heat insulation to replace the existing methods C 93 covering compression, flexure and shrinkage testing of this material. A revised standard was discussed at the meeting and it is expected to be approved as tentative this year after being published in the committee's report. Since the specifications for fire-clay brick for marine boiler service are not in general use, other specifications having superseded them, particularly one issued by the U. S. Navy, they are to be withdrawn.

Committee C-8 believes that the specifications C 49 covering quicklime and hydrated lime for the manufacture of silica brick need revision and therefore the subcommittee on specifications will discuss the subject with the Society's Committee C-7 on Lime which has jurisdiction over this specification.

Since both Committee C-8 and Committee C-16 on Thermal Insulating Materials are concerned with block insulation, a joint committee will recommend exact scopes of the two groups in this field so that there will not be overlap. Committee C-8 has arbitrarily set about 1000 F. as the low end of the range in which it is interested, but since test methods used on block above 1000 F. are probably applicable to material used at lower temperatures it would seem that only one set of test methods should appear in A.S.T.M. specifications.

The subcommittee on heat transfer is conducting cooperative tests in several laboratories on measuring the thermal conductivity of block insulation. The reports of all of the laboratories are not complete so the final report to the committee will not be made until the fall of 1939. This subcommittee is also still cooperating with the National Bureau of Standards in the development of a standard apparatus for the determination of the thermal conductivity of refractories at elevated temperature.

Committee C-9 on Concrete and Concrete Aggregates

The subcommittee on methods and apparatus for testing concrete is recommending revisions in the methods of making compression tests (C 39), flexural strength (C 78), making and sorting compression specimens in the field (C 31), securing specimens of concrete from structures (C 42), and compression tests with portions of beams (C 116).

The tests for consistency of portland cement concrete (slump test) (D 138) and for yield of concrete (C 138) were recommended for adoption as standard, as were the existing tentative definitions for "fineness modulus," "admixture," "crushed stone," and "gravel" which were published under the A.S.T.M. designation C 125 – 36 T.

Committee C-9 has been interested since its organization in 1914 in the preparation of standard definitions for concrete and concrete aggregates. In this work the committee has had the cooperation of members of the American Concrete Institute. Since the establishment of authoritative nomenclature for concrete is of particular interest to both organizations it has been decided to organize a joint committee on definitions, with representatives from both the A.S.T.M. and the A.C.I.

The subcommittee on specifications and methods of test of aggregates has prepared important revisions in the tentative specifications for concrete aggregates (C 33) and the specifications as revised will be recommended for adoption as standard. The method of test for unit weight of aggregate (C 29) will also be revised this year and adopted as standard to supersede the present method C 29 – 27.

Committee C-9 took action at its meeting to join with A.S.T.M. Committee D-4 on Road and Paving Materials in recommending the revision and adoption as standard of the tentative method of test for abrasion of coarse aggregate by use of the Los Angeles machine (C 131).

The committee also approved for reference to letter ballot the adoption as standard of six existing tentative standards which cover specifications for lightweight aggregate (C 130), methods of tests for clay lumps (C 142), coal and lignite

in sand (C 123), sieve analysis of fine and coarse aggregates (C 136), specific gravity and absorption of coarse aggregate (C 127) and fine aggregate (C 128).

There has been much interest in tests for determining the soundness of concrete aggregates. A method using sodium sulfate or magnesium sulfate (C 88) has already been established. This subject, however, has been given further study and the committee is planning to publish in its report this year as information a "Proposed Method of Test for Soundness of Aggregate by Use of Magnesium Sulfate." Should this be adopted subsequently by the Society it would represent a radical revision in the existing tentative standard.

The development of a proposed pH method of test for determining organic impurities in sand has been completed.

Committee C-9 has followed the practice of encouraging the preparation of technical papers by its members dealing with subjects in which the committee is interested. There are three such papers planned for inclusion in the annual report of the committee this year, as follows:

"Some Observations of the Water Vapor Permeability of Concrete," by H. J. Barre, Research Assistant Professor, Agricultural Engineering Section of the Iowa Agricultural Experiment Station;

"A Study of Methods for Measuring Permeability with a Comparison of the Results Obtained by Each," by W. M. Dunagan, Assistant Professor, Civil Engineering Department, Iowa State College;

"A Statistical Analysis of Compression Tests on Mortar Cylinders, Cubes, and Prisms," by H. W. Leavitt and H. A. Pratt of the Maine Technology Experiment Station, University of Maine.

Committee C-12 on Mortars for Unit Masonry

Committee C-12 discussed a report of its Subcommittee IV which had been requested to prepare specifications for fine aggregate for masonry mortar. Previously the subgroup had considered suggestions received on an earlier draft of the specifications. The special subcommittee had arrived at the conclusion that it was not practicable, at this time, to propose a well-defined recommendation for grading of fine aggregates for masonry mortar but that instead (for the time being at least, and perhaps permanently) the specifications should be restricted to a statement of the fundamentally desirable characteristics with respect to grading. As a result, the subcommittee presented recommended specification requirements for fine aggregate for masonry mortar—these are to be referred to letter ballot. The specifications require that fine aggregate for use in masonry mortar shall consist of fine granular material composed of hard, strong, durable mineral particles free from injurious amounts of saline, alkaline, organic, or other deleterious substances.

The specifications are in conventional form except as to the grading requirements. Instead of specific limitations, the specifications outline recommended practices to guide the engineer in preparing purchase specifications for aggregates. They appear in this BULLETIN on page 34.

The committee also considered a report from two other subcommittees, namely, on specifications for mortars and on methods of test for mortars. Joint consideration had been given by these groups to the preparation of specifications for mortar for unit masonry. The committee accepted for publication as information a second draft of the proposed specifications which cover mixtures of cementitious materials and sand used or intended to be used as mortar for unit masonry. Under cementitious materials are included portland cement, natural cement, slag cement, puzzolan cement, masonry cement, hydraulic lime, hydrated lime, lime putty, and mixtures of any of these materials. Sand includes the fine granular material resulting from the natural disintegration of rock or from the crushing of a friable sandstone rock as well as artificially prepared stone sand and slag sand. These proposed specifications also apply to mortars containing such admixtures as may be added for the purpose of affecting their properties. Four grades of mortar are covered, classified according to durability and strength.

In connection with the mortar specifications, the committee also accepted for publication as information a "Primer" on specifications and tests for masonry mortar. The primer is intended to furnish general information on questions that might be raised by architects, construction engineers and others concerning masonry mortar and for the interpretation of laboratory tests. The information in the primer is not intended to be authoritative but represents the best judgment of the committee responsible for its preparation.

It was reported that the committee has under way a cooperative series of tests on masonry-cement mortar and cement-lime sand mortar which are being carried on by the members of the committee and other interested cooperating laboratories outside the committee. It is expected that this investigation will result in considerable data and information which will be of much assistance in the future committee work.

Committee C-15 on Manufactured Masonry Units

After discussing the requirements of several of its specifications including the following: hollow non-load-bearing concrete masonry units (C 129); concrete masonry units for use in construction of catch basins and manholes (C 139); and sampling and testing concrete masonry units (C 140), it was decided to recommend that these items, all of which are tentative, be adopted as standard.

New specifications were considered for solid load-bearing concrete masonry units and these are to be proposed for publication as a new A. S. T. M. tentative standard.

Concerning the specifications for building brick (made from clay or shale) (C 62), revisions were considered covering the optional freezing and thawing test requirements. However, after extended discussion no definite action was taken, the matter being referred to the subcommittee on building brick for study and report.

In recognition and appreciation of the work which Professor T. R. Lawson has done in connection with the work of the committee, he was elected to the position of Permanent Honorary Chairman.

Committee C-16 on Thermal Insulating Materials

One of the chief activities of Committee C-16 on Thermal Insulating Materials was the organizing of the Symposium on Thermal Insulating Materials held in Columbus, Ohio, as part of the 1939 A.S.T.M. Regional Meeting. Four important papers were presented and much profitable discussion was given. It is expected that the symposium will be issued in the form of a special publication—further details of this will be announced.

Meetings were held by five of the six existing subcommittees and satisfactory progress was made toward the establishment of standard test methods for insulating materials.

A meeting was also held of the Joint Committee on Thermal conductivity which committee now includes representation from the American Society of Heating and Ventilating Engineers, the American Society of Refrigerating Engineers and the National Research Council as well as from the A.S.T.M.

Increasing interest in the work of Committee C-16 is evident from the inquiries received and the new applications for membership. The results of the committee's work should be of much benefit to both producers and consumers.

Subcommittees of Committee D-3 on Gaseous Fuels

Two of the subcommittees of Committee D-3 on Gaseous Fuels met during Committee Week, these groups being Subcommittee III on Determination of Calorific Value of Gaseous Fuels and Subcommittee V on Determination of Impurities of Gaseous Fuels.

The group working on calorific value discussed a proposed standard test method for determining calorific value of gaseous fuels with the water flow calorimeter. Special attention was given to a humidity control method and it was decided to appoint a section to compare the possibilities of this method with others. It is planned to ask interested companies to construct the equipment needed and run trials of the method, the information resulting to be made available to the subcommittee for study.

The appointment was announced of a special section to conduct a critical study of humidity corrections and to draft suggested methods of procedure for the elimination of errors due to atmospheric humidity. It is planned that this work would include also a study of all published material.

Since the need has been recognized of standardizing calorimeter thermometers, the subcommittee plans to collect data to be submitted to Technical Committee XII of the Society's Committee E-1 on Methods of Testing for study and recommendations.

Subcommittee V on Determination of Impurities of Gaseous Fuels reviewed the revised methods of test for total sulfur by the Referees' Apparatus. As a result, it was decided to conduct tests with different gases and different rates to determine whether the burner in the Referees' method will give satisfactory combustion.

In connection with the determination of sulfur in gaseous fuels, the following methods were submitted for comment, criticism, and review by the members:

(a) Method for the "Determination of Organic Sulfur in Gaseous Fuels by the Catalytic Hydrolysis Method" sponsored by Dr. R. L. Dodge of the E. I. du Pont de Nemours & Co. This method is proposed for use where very high accuracy is desired in the determination of very small amounts of sulfur in gas.

(b) Method for determination of total sulfur in liquefied petroleum gases, submitted by the Phillips Petroleum Co.

Progress reports were submitted on methods for the determination of dust, metallic carbonyls, oxides of nitrogen; and on methods for the determination of tar fog and condensible oils and vapors, gums, cyanogen, and ammonia, by W. J. Huff and C. D. Ulmer, respectively, chairmen of the sections in charge.

Committee D-4 on Road and Paving Materials

A number of proposed standards were considered at the Columbus meeting of Committee D-4 and in certain cases are to be published as information and for comment. In this category is a proposed specification for slow setting emulsified asphalt for use in densely graded mixes. Another method to be published as information is a new procedure for sieve analysis of mineral fillers. With this will appear data resulting from work of twelve cooperating laboratories which gives the reproducibility of results with the test. Consideration is being given to definitions of flat and elongated particles of aggregates and a method for detecting soft particles in aggregates is also being drafted.

A proposed specification covering expansion joint materials for roads was submitted by one of the D-4 subcommittees and decision was reached to publish it as information. Specifications for cut-back asphalt (medium curing) and cut-back asphalt (rapid curing) are being considered. Four existing tentative standards are recommended for adoption as standard. These include specifications for quick-setting emulsified asphalt (D 401), testing emulsified asphalts (D 244) and tests for specific gravity and absorption of coarse aggregate (C 127) and fine aggregate (C 128).

Decision was reached to recommend certain revisions in three specifications covering various types of emulsified asphalts with the thought that these specifications (emulsified asphalt (for coarse aggregate plant mixes) (D 397), for retread and coarse aggregate mixes (D 398), and for heavy premix-summer grade (D 399)) would be adopted as standard or if possible combined into a single standard.

The method of test for loss on heating of oil and asphaltic compounds (D 6) is to be revised. Changes are to be proposed in two of the distillation tests (D 20 covering distillation of tar products suitable for road treatment and D 402 covering distillation of cut-back asphaltic products).

Committee D-5 on Coal and Coke

A report was received from the subcommittee on dustiness that it had reached agreement on the standardization of a testing procedure for determining the relative dustiness of either coal or coke. By these procedures it will be possible to evaluate the effectiveness of various treatments available for eliminating the formation of dust which is often objectionable when handling solid fuels. The application of various treatments to coal and coke for the reduction of dust has greatly increased the consumer's satisfaction with these fuels, especially for domestic use.

Another important project involves the development of a standard method for determining ignitibility of coal and coke. Following a recent meeting of the subgroup responsible, agreement was reached on an essential point, namely, a statement or definition of this property as follows:

"The ignitibility of a fuel is that characteristic which determines the ease with which the fuel may be brought to a condition of self-supporting, active oxidation. The ignitibility is governed not only by the inherent chemical characteristics of the fuel that determine its rate of oxidation at various temperatures but also by the physical characteristics of the fuel and its surroundings that determine the rate at which it can be heated. Among these physical characteristics are (1) the size of the pieces of fuel, (2) the specific heat of the fuel, (3) the thermal conductivity of the pieces and the aggregate, (4) the rate at which the oxygen or air is brought into contact with the fuel, and (5) the rate of heat loss to

the surroundings. Chemical and physical changes, such as melting and decomposition of bituminous coal, may occur as the fuel is heated."

An ignition temperature of a fuel cannot, therefore, be considered an independent characteristic, but such a temperature, at which the rate of oxidation attains some definite value under standardized conditions, may be a useful criterion of the performance of the fuel in combustion equipment.

It was announced that the group concerned with plasticity and swelling of coals for coke-making had distributed a series of different coals to various cooperating laboratories to be tested by different methods under consideration. The first series of such tests have been completed and the data are being compiled and studied. All methods now in use are necessarily empirical in nature and require close standardization to be of value.

A special section of the subcommittee has been formed to study swelling of coals when fired on grates since this is a different problem from expansion during coking.

Committee D-8 on Waterproofing and Roofing Materials

One of the recommendations being made involves a consolidation of three existing specifications for asphalt mastic [acid-resisting, D 223; for use in waterproofing (asphalt cement, mineral filler, mineral aggregate) D 491; and general, D 169] to be issued as a new tentative standard. The grade of asphalt mastic to be covered by the new combined specification is suitable for waterproofing the floors of buildings and bridges, for reservoirs, waterways, subways, and similar structures. It is not intended for use as a pavement for either foot or vehicular traffic. Details are given concerning the character of mastic and the asphalt cement is prescribed with definite requirements.

As a result of consideration extending over several years, including studies of data resulting from cooperative tests, the committee plans to have published a recommended practice of accelerated weathering testing of roofing materials. This will undoubtedly be of considerable interest in this field.

In order to bring certain specifications up to date for inclusion in the 1939 Book of ASTM Standards (to be issued in November), Committee D-8 is offering changes for action at the annual meeting in June. The requirements for coal-tar saturated felt (D 227) are involved, one change specifying an average strength with fiber grain of 30 lb. min., across grain, 15 lb. min. The pliability is to be such that eight out of ten strips shall not crack when bent 90 deg. over a rounded corner of ½ in. radius.

Requirements for asphalt saturated asbestos felt (D 250) are being modified; also the specifications for saturated woven cotton fabrics (D 173). The average strength crosswise of roll is to be 50 lb. min. instead of 40; net weight per square yard and thread count are to be changed.

Finally, to put into effect a decision reached last year to insert requirements for flash point in all specifications for asphalt and coal-tar pitch, the tentative specifications for asphalt (D 312) will carry a minimum flash point (Cleveland open cup) of 375 F.

Committee D-11 on Rubber Products

Among numerous important actions was the decision to organize a new Technical Committee on Automotive Rubber. It is anticipated that the work of this new group will include development of standards for rubber used in motor mountings and similar automotive applications; and possibly other rubber products such as V-belts and various types of hose. In this work the committee will have the cooperation of the Society of Automotive Engineers.

Committee D-11 has completed a survey of the classes of packings and of specifications for these materials in current use, including rubber sheet packings (both cloth inserted and all rubber) and asbestos sheet packing. This information is being compiled for use in the standardization of test methods for these products.

The subcommittee on tape gave consideration to possible revision of the present cold adhesion requirements for existing A.S.T.M. friction tape to establish separation limits of 8 ± 4 in. per min. instead of the present maximum of 15 in. per min. The reason for this proposal is to endeavor to make A.S.T.M. tape acceptable for railway signal work as well as for general electrical purposes.

The tentative methods of sample preparation for physical testing of rubber product (D 15) were approved for adoption as standard. The tentative method of tension testing of vulcanized rubber (D 412) is to be revised and continued as tentative. One change will make the ACS and Federal Specification Board micrometer used for thickness measurements the A.S.T.M. standard in place of the present one. The new micrometer will employ 3 oz. dead weight load on a ¼ in. foot in place of the present 9 oz. load. Other changes will take into account the grain effect in rubber specimens and will permit the use of compensating head testing machines for all tension machines.

The subcommittee on physical testing of rubber products has prepared a questionnaire which will be circulated in the immediate future covering all details of tension tests. From this it is expected to determine whether further changes are necessary and particularly to aim at a standard practice for elimination of imperfect specimens or questionable results and for a statistical treatment of data obtained.

Two cooperative laboratory checks for determining small amounts of copper and manganese in rubber have been completed. Discrepancies between laboratories using the same methods have been found to be very considerable in the case of both manganese and copper, indicating that the methods in their present form are not satisfactory. The subcommittee in charge is continuing its work in an effort to develop a suitable analytical procedure for determining these elements. The committee has also decided to undertake a study looking toward a general revision of the methods of chemical analysis of rubber. This work will be handled by a special section.

Committee D-11 approved the addition of a footnote in the test for abrasion resistance (D 394) calling attention to the availability of A.S.T.M. standard specimens for abrasion tests from V. L. Smithers Laboratories.

The subcommittee on life tests has completed a thorough study of the air pressure heat test and has concluded that the present A.S.T.M. procedure is satisfactory as published, with reference to reasonable reproducibility in various laboratories. A section of this subcommittee was authorized for the development of a standard aging test procedure using artificial light.

The group working on rubber products for absorbing vi-

bration appointed a section to investigate further the method for determining compression set. It also presented an alternate method for hardness of rubber using a Pusey and Jones Plastometer as a new tentative method.

The subcommittee on dynamic fatigue testing considered test methods for compression flexing using three instruments, the Goodrich Flexometer, the Firestone Compressatometer, and the St. Joseph Lead Co. flexing machine. Because of the importance of this type of test in evaluating rubber for heat resistance in flexing and resistance to deterioration caused by compression hysteresis it was decided to incorporate the procedures mentioned in a new tentative method of test.

A study of viscosity determination by several methods has been completed by the subcommittee on tests of liquid rubber products and it expects to recommend shortly a tentative method for determining viscosity of cements.

The subcommittee on sponge rubber has completed a questionnaire with which to survey methods in current use for determining the physical properties of sponge rubber. The existing chemical methods of the A.S.T.M. are considered satisfactory for this product.

The subcommittee on hard rubber has completed proposed methods for physical tests, chemical analyses, and electrical tests of this material and will recommend these to the Society for publication as tentative.

The tentative methods of test for adhesion of vulcanized rubber (friction test) (D 413) and adhesion to metal (D 429) are being recommended for adoption as standard. These were first issued in 1935 and revised in 1936.

In the three specifications D 27, D 353, and D 469, covering various types of insulated wire and cable, the voltage limits for shielding will be lowered in accordance with industrial practice. Wall thickness on No. 8 A.w.g. wire is to be changed from 4/64 in. to 3/64 in., but this is provisional on similar simultaneous action in Underwriters Laboratory Specifications and the National Code. Also in D 27 (Class AO, 30 per cent, Hevea Rubber Compound) changes will be made in requirements for saturants and finishes to incorporate the Underwriters Laboratories' specifications for interior finishes.

The committee accepted a specification for insulating compound for a tough rubber jacket for electric cords and cables to be issued as tentative this year with the understanding that additional requirements may be developed later and agreed to by the test section for inclusion in the specifications.

Committee D-18 on Soils for Engineering Purposes

Important actions taken by Committee D-18 included the virtual completion of three tests covering soil-cement mixtures and one for soil stabilization with emulsified asphalt. The scope of this last named method involves the determination of absorption of soil specimens and the stability and shear resistance of the same specimens. After they have been subjected to the absorption test, the results obtained are used to determine the changes in soil properties produced by stabilization and to determine the efficiency of stabilization by resistance to plastic flow and to shear.

The three methods for soil-cement mixtures are designed for laboratory use. The first covers the determination of moisture-density relations and the scope indicates it determines the relation between moisture content of the mixtures and resultant densities (oven-dry weight per cu. ft.) when the mixtures are compacted in the laboratory before cement hydration in a manner similar to that achieved in the field with sheep's-foot rollers operating on successive layers of loose material approximately 9 in. in thickness, so that the rollers are effective in compacting each layer from the bottom up.

The second method evaluates the durability of a soil-cement mixture of known composition by measuring soil losses, moisture changes, and volume change (swelling and shrinkage) produced by repeated freezing and thawing of specimens of known density and moisture content, comparable to density and moisture attained in the field with the same materials when compacted with sheep's-foot rollers.

The third method determines durability under repeated wetting and drying, instead of the freezing and thawing procedure.

The committee is developing a Symposium on Shearing Resistance of Soils to be held at the 1939 ASTM Annual Meeting, June 26 to 30 in Atlantic City. A committee-sponsored exhibit of testing equipment in this field is also being considered.

INFORMATION ON MEMBERSHIP—AMERICAN SOCIETY FOR TESTING MATERIALS

ADVANTAGES OF MEMBERSHIP

1. Association at meetings.
2. Opportunity to keep in touch with major developments in materials.
3. Possession of A.S.T.M. Standards.
4. Opportunity to participate in technical programs.
5. Close identification with leading technical men.
6. Satisfaction from support of needed work.
7. And *finally*, these extensive publications:

I. Book of Standards and Tentative Standards and Supplements.
II. Proceedings (Annual).
III. ASTM Bulletin (Bimonthly).
IV. Year Book (Annual).
V. Chemical Analysis of Metals.
VI. Index to Standards (Annual).
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Totaling 3000 to 4000 pages yearly.

Endorsement by two members; Election by Executive Committee.

Annual Dues:

Individual, government departments (city, state, federal), libraries, schools, colleges	$15.00
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Sustaining Members	100.00
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Membership application blank and further details on A.S.T.M. work in the field of engineering materials, including lists of publications and standards, furnished gladly on request. Write to A.S.T.M., 260 S. Broad St., Philadelphia, Pa.

Calendar of Society Meetings

(Arranged in Chronological Order)

EASTERN REGIONAL FOUNDRY CONFERENCE—American Foundrymen's Association chapters, in cooperation with Dept. of Mech. Eng., Rutgers Univ., April 1, New Brunswick, N. J.

AMERICAN CHEMICAL SOCIETY—97th Meeting, April 3-7, Baltimore, Md.

AMERICAN CERAMIC SOCIETY—41st Annual Meeting, April 16-21, The Stevens, Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS—Spring Meeting, April 19-21, Chattanooga, Tenn.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS—22nd National Open Hearth Convention, April 26-28, Cleveland, Ohio.

AMERICAN OIL CHEMISTS SOCIETY—Annual Meeting, May 4 and 5, New Orleans, La.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS—Semi-annual Meeting, May 15-17, Akron, Ohio.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS—26th Spring Meeting, May 22 and 23, Hotel Hershey, Hershey, Pa.

SOCIETY OF AUTOMOTIVE ENGINEERS WORLD AUTOMOTIVE ENGINEERING CONGRESS—May 22-June 8, New York City, Indianapolis, Detroit, San Francisco.

AMERICAN WATER WORKS ASSOCIATION—Annual Convention, June 11-15, Atlantic City, N. J.

American Society for Testing Materials—Forty-second Annual Meeting and Fifth Exhibit of Testing Apparatus and Related Equipment, June 26-30, Chalfonte-Haddon Hall, Atlantic City, N. J.

Weston Golden Anniversary

THERE has been received from the Weston Electrical Instrument Corp., in Newark, N. J., a book entitled "Measuring Invisibles" which is a 50-year record of this company, said to be the largest manufacturer of electrical measuring instruments. The book mentions highlights in the life of Dr. Edward Weston, the founder of the business, and other executives of the company including the chief engineer, W. N. Goodwin, Jr., who is a personal member of the A.S.T.M. and a member of Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys.

Folders and Literature Received

TINIUS OLSEN TESTING MACHINE CO., 500 North 12th St., Philadelphia, Pa. Bulletin No. 17. A twelve-page folder describing modern plastic material testing machines, designed especially for America's "newest and fastest growing industry." Illustrated.

EIMER & AMEND, INC., 205-223 Third Ave., New York City. New Catalog 88-C, "Chemicals and Drugs," including a list comprising many thousands of items. The listings are grouped, sectionally divided, alphabetically arranged and cross indexed for easy reference. Full data regarding grades, prices and usual available packages are also clearly indicated.

RIEHLE TESTING MACHINE DIVISION, AMERICAN MACHINE AND METALS, INC., East Moline, Ill. A 20-page booklet describing the Vickers Pyramid Hardness Testing Machine. Another folder, about twenty pages, covers machines and accessories for testing non-metallic materials. Still another folder describes universal hydraulic testing machines.

HUMBOLDT MANUFACTURING CO., 2014 N. Whipple St., Chicago, Ill. Supplementary Catalog 9-C. A 32-page booklet listing testing equipment for cement, concrete, aggregates and soils, including testing sieves, balances and weights. A number of instruments referred to in A.S.T.M. methods are described.

PRECISION SCIENTIFIC CO., 1730-54 N. Springfield Ave., Chicago, Ill. Catalog 165. A 112-page catalog bound in heavy paper covers with wire ring binding describing in detail a large number of items produced for testing petroleum products. Profusely illustrated. References to apparatus required in A.S.T.M. methods are facilitated by a separate A.S.T.M. index.

CORNING GLASS WORKS, Laboratory and Pharmaceutical Division, Corning, N. Y. Catalog No. LP 18. This 128-page catalog covering Pyrex Brand Laboratory Glassware lists some 2300 individual items including over 700 not previously covered. A detailed subject index enables reference to particular items. The catalog covers types of glassware required in carrying out many A.S.T.M. tests, the Index referring to A.S.T.M. designations.

NEW MEMBERS TO MARCH 7, 1939

The following 94 members were elected from January 3 to March 7, making the total membership 4173:

Company Members (16)

ABBOT WORSTED CO., H. R. Anderson, Laboratory Head, Forge Village, Mass.

ACHESON INDUSTRIES, INC., Raymond Szymanowitz, Vice-President and Technical Director, 444 Madison Ave., New York City.

BERRY BROTHERS, Gale Smith, Chief Chemist, 211 Leib St., Detroit, Mich.

IMMEL-MABIE CO., H. W. Mabie, Jr., Partner, 104 S. Main St., Fond du Lac, Wis.

KEY CO., Fred Riggan, Metallurgist, Box 494, East St. Louis, Ill.

M & H VALVE AND FITTINGS CO., C. S. Martin, President, Box 909, Anniston, Ala.

OLD DOMINION CLAYS, INC., J. G. Earnest, Secretary-Manager, 112 Exchange Building, Richmond, Va.

PETROLEOS MEXICANOS, V. C. Herrera, General Manager, Ave. Juarez 92-94, Mexico, D. F., Mexico.

NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO., R. L. Angell, In Charge of Testing Laboratory, Newport News, Va.

SCREW MACHINE SPECIALTY CO., R. P. Suess, President, 5637-43 Butler St., Pittsburgh, Pa.

SEAGRAM AND SONS, INC., JOSEPH E., H. F. Willkie, Vice-President, Seventh Street Road, Louisville, Ky.

SOCIEDADE ANONIMA INDUSTRIAS REUNIDAS F. MATARAZZO, Laboratorio Chimico Central, Edificio Conde Francisco Matarazzo, São Paulo, Brazil.

TENNEY ENGINEERING, INC., Dwight Tenney, President, 46 Farrand St., Bloomfield, N. J.

TOUSEY VARNISH CO., J. M. Gokay, Works Manager, 520 W. Twenty-fifth St., Chicago, Ill.

TUBE TURNS, J. H. Romann, Consulting Engineer, 224 East Broadway, Louisville, Ky.

WOOD RIDGE MANUFACTURING CO., THE, W. M. Stieh, Vice-President, Box 67, Carlstadt, N. J.

Individual and Other Members (66)

ABDUN-NUR, E. A., Assistant Engineer, U. S. Office of Indian Affairs, 215 Treasure State Building, Billings, Mont.

AYTON, T. W., Planning Engineer, Indianapolis Power and Light Co., 17 N. Meridian St., Indianapolis, Ind.

BAILEY, L. R., Assistant Division Purchasing Agent, E. I. du Pont de Nemours and Co., Inc., 350 Fifth Ave., New York City.

BARNES, F. A., Works Manager, Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.

BIRMINGHAM PUBLIC LIBRARIES, REFERENCE LIBRARY, H. M. Cashmore, City Librarian, Ratcliff Place, Birmingham, England.

BODMER, ALBERT, Chief Chemist, Heberlein and Co., A. G., Wattwil, St. Gall, Switzerland.

BOON, G. B., Chemical Engineer, 412 San Antonio St., Austin, Tex.

BROWN, W. DURAND, Research Engineer, Western Waterproofing Co., 410 Murphy Building, Detroit, Mich.

BUCK, W. E., Sheet Metallurgist, Continental Steel Corp., Kokomo, Ind.

CAVARRA, ALFONSO, Materials Engineer, City and County of Denver Testing Laboratory, 811 Larimer St., Denver, Colo.

CHAMBERLAIN, D. S., Testing Engineer, The American Brass Co., Waterbury, Conn. For mail: 31 Johnson St., Ansonia, Conn.

CHRISTENSEN, CHRISTEN, Chief Engineer, Electrical Engineers Equipment Co., Twenty-fifth Ave. and Division St., Melrose Park, Ill.

CINCINNATI, PUBLIC LIBRARY OF, ORDER DEPT., 629 Vine St., Cincinnati, Ohio.

COY, W. M., Chief Chemist, Wilson Sporting Goods Co., 2037 N. Campbell Ave., Chicago, Ill.

DIETERT, H. W., President, Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.

DIETZ, R. O., Director of Laboratory, Marshall Field and Co., Manufacturing Division, Box 22, Spray, N. C.

DIRECCION GENERAL DE AVIACION NAVAL, MINISTERIO DE MARINA, Calle Austria 2561, Buenos Aires, Argentina.

DOWNS, C. R., Vice-President and Treasurer, Weiss & Downs, Inc., 50 E. Forty-first St., New York City.

EMMETT, R. C., Manager, Chicago Office, Pittsburgh Testing Laboratory, 205 W. Wacker Drive, Chicago, Ill.

FARR, HERBERT, Engineer, Sanitary Pipe Co., Alexander City, Ala.

FORREST, A. G., Metallurgist, Republic Steel Corp., 118th St. and Burley Ave., Chicago, Ill.

FULLER, S. L., Vice-President, John F. Casey Co., Box 1888, Pittsburgh, Pa.

GOLDBERG, ERICH, Chemist, S. Friedman and Sons, Brooklyn, N. Y. For mail: 144-41 Roosevelt Ave., Apartment 1 D, Flushing, Long Island, N. Y.

GROLL, P. A., Chemist, Lehigh Portland Cement Co., Oglesby, Ill.

HOWARD, H. S., Industrial Engineer, Bank of Commerce Building, Oakland, Calif.

JORDAN, C. W., Technician, United Gas Improvement Co., Engineering Laboratory, Chester, Pa.

KLINE, J. F., Manager, Pittsburgh Testing Laboratory, 2224 N. Prospect Ave., Milwaukee, Wis.

KUHN, W. E., Manager, Technical Research Division, The Texas Company, 135 E. Forty-second St., New York City.

KUNKEL, W. J., Forgeman, Frank Kunkel and Son, 2-8 Wolcott St., Readville, Mass.

LARSON, B. E., Mechanical Engineer, Locomotive Firebox Co., 310 S. Michigan Ave., Chicago, Ill.

LEWELLEN, C. P., Designing Engineer, Howard R. Green Co., Engineers, 210 Bever Building, Cedar Rapids, Iowa.

LINDLEY, G. W., Germantown Machine Works, 5120 Wakefield St., Germantown, Philadelphia, Pa.

LISSNER, H. R., Instructor of Engineering Mechanics, College of Engineering, Wayne University, Detroit, Mich.

LUDWIG, E. C., Metallurgical Engineer, National Bearing Metals Corp., 4930 Manchester Ave., St. Louis, Mo.

MACBRIDE, D. S., Vice-President, Hercules Cement Corp., 1700 Walnut St., Philadelphia, Pa.

MARBURG, EDWIN, Chief Metallurgist, Vandergrift Works, Carnegie-Illinois Steel Corp., Vandergrift, Pa.

MCCURDY, F. T., Superintendent, Haynes Stellite Co., Kokomo, Ind.

MCGOVERN, J. F., Supervisor of Bridge Maintenance and Operation, Commonwealth of Massachusetts, Department of Public Works, Boston, Mass. For mail: 36 Pleasant Hill Ave., Dorchester, Mass.

MUSEUM OF SCIENCE AND INDUSTRY, LIBRARY, Fifty-seventh St. and Lake Michigan, Chicago, Ill.

NORRIS, E. S., Technical Advisory Dept., Revere Copper and Brass Incorporated, 24 N. Front St., New Bedford, Mass.

OAKLAND PUBLIC SCHOOLS, C. A. Whitton, Chief Engineer, Department of Architecture and Engineering, 1025 Second Ave., Oakland, Calif.

PATTERSON, J. EDWARD, Vice-President, Arthur H. Thomas Co., 230 S. Seventh St., Philadelphia, Pa.

PAXTON, J. L., JR., President, Paxton-Mitchell Co., 2614 Martha St., Omaha, Nebr.

PEREZ, LAWRENCE, Instructor, Cooper Union, New York City. For mail: 20 W. Raleigh Ave., West Brighton, Staten Island, N. Y.

POMEY, JACQUES, Director of Research and Metallurgy, Usines Renault, Billancourt, Seine, France.

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PUBLIC IMPROVEMENT COMMISSION, R. E. L. Williams, Assistant Supervising Engineer, 326 City Hall, Baltimore, Md.

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ROWAT, R. M., Commercial Research Manager, Salt Division, Canadian Industries Limited, 80 Prince St., Montreal, P. Q., Canada.

SCOULAR, S. G., City Engineer-Elect, 11 Prestwick St., Dunedin, N. W. 1, New Zealand.

SELQUIST, ROLF, Electrical Engineer, Copperweld Steel Co., Glassport, Pa.

SHEA, J. A., Rayon Supervisor, Mount Hope Finishing Co., North Dighton, Mass.

SHEAFER, T. E., Office Engineer, National Slag Assn., 644 Earle Building, Washington, D. C.

SHUGER, L. W., Technical Director, Baltimore Paint and Color Works, Inc., 150 S. Calverton Road, Baltimore, Md.

SMITH, R. G., Engineer, Alloy Metal Wire Co., Prospect Park, Pa.

SMITH, S. E., Associate Engineer, U. S. Bureau of Reclamation, U. S. Customhouse, Denver, Colo. For mail: 1027 Fillmore St., Denver, Colo.

UNIVERSITY OF CINCINNATI LIBRARY, Burnet Woods Park, Cincinnati, Ohio.

UNIVERSITY OF ILLINOIS LIBRARY, Urbana, Ill.

VELA HUERGO, JULIO, Associate Professor of Testing Materials, Facultad de Ciencias Exactas, Físicas y Naturales, University of Buenos Aires, Calle Peru 222, Buenos Aires, Argentina.

WRAY, EDWARD, 9 S. Clinton St., Chicago, Ill.

WHITE, J. R., Manager, Pittsburgh Testing Laboratory, 317 Merchants and Manufacturers Building, Houston, Tex.

YOAKLEY, P. R., Manager, Pittsburgh Testing Laboratory, 2729 College St., Jacksonville, Fla.

Junior Members (12)

AUFDERHEIDE, K. J., Sales Manager, New Ulm Brick and Tile Yards, Box 177, New Ulm, Minn.

COBBS, H. J., 8540 160th St., Jamaica, N. Y.

GILLINGHAM, HAROLD G., Chemist, Franklin Steel Works, Franklin, Pa. For mail: 162 Front St., Franklin, Pa.

HISER, HENRY, Engineer, Springfield Metallic Casket Co., 1760 N. Fountain Ave., Springfield, Ohio.

JACOBS, L. J., Chemical Engineer, S. Obermayer Co., Chicago, Ill. For mail: 4919 N. Talman Ave., Chicago, Ill.

JONAP, R. D., Junior Civil Engineer, City of New York Department of Parks, New Parks Design and Construction Division, New York City. For mail: 520 W. 163d St., New York City.

KINNEY, P. W., Adhesives Research Chemist, Armstrong Cork Co., Lancaster, Pa. For mail: 431 Nevin St., Lancaster, Pa.

LEEDOM, R. P., Junior Engineer, The Atlantic Refining Co., Philadelphia, Pa. For mail: 2014 Shunk St., Philadelphia, Pa.

THOMAS, R. D., JR., Chemical Engineer, Arcos Corp., 401 N. Broad St., Philadelphia, Pa.

TURNER, C. B., Attendant, Connecticut State Hospital, Middletown, Conn. For mail: Box 154, East Berlin, Conn.

WARNER, J. G., Chemist, Tung Sol Lamp Works, Inc., 370 Orange St., Newark, N. J.

WEBERLING, R. P., JR., Laboratory Assistant, Wright Aeronautical Co., Paterson, N. J. For mail: 863 Melrose Ave., New York City.

PERSONALS

* * * News items concerning the activities of our members will be welcomed for inclusion in this column.

A. R. WELCH, formerly Plant Manager, Reilly Tar and Chemical Corp., Dover, Ohio, is now President and General Manager, Ziwel Plastics Corp., Dover, Ohio.

J. F. JOHNSON, who was Inspector of Tests, Florida East Coast Railway, St. Augustine, Fla., is now connected with Dearborn Chemical Co., Chicago, Ill., as Service Engineer.

R. L. VAN NAME is with the Will Corp., New York City. He was formerly Manager, R. L. Van Name Co., New York City.

T. G. DELBRIDGE, Manager, Research and Development Dept., The Atlantic Refining Co., Philadelphia, Pa., has been appointed chairman of the American Petroleum Institute's 1939 Committee on Testing Methods and Specifications.

HARRY BENNETT, formerly Chief Chemist, Chemical Publishing Co. of New York, Inc., New York City, is now Chief Chemist, Glyco Products Co., Inc., New York City.

A. T. ROGERS is Manager, Technical Service Dept., North American Cement Corp., New York City. He was formerly Chief, Concrete Division, District of Columbia, Washington, D. C.

H. J. BAKER, who was connected with The Port of New York Authority, New York City, as Engineer, Steel Inspection, is now Inspecting Engineer, New York City.

At the recent meeting of the Pacific Coast Building Officials Conference, GEORGE MOSER, Professor of Civil Engineering, Stanford University, was unanimously elected to fill the position of research engineer for the Conference. Mr. Moser will act in a consulting capacity and will formulate test programs, conduct tests and issue reports of all research department projects.

K. B. WOODS, formerly Assistant Engineer, Bureau of Tests, Ohio State Highway Department, Columbus, Ohio, is now Assistant Professor, Department of Civil Engineering, Purdue University, Lafayette, Ind.

FREDERIC BENARD is now Assistant to the General Superintendent, Mining and Smelting Division, The International Nickel Co. of Canada, Ltd., Copper Cliff, Ont., Canada.

LEO BESOZZI, formerly Assistant Chief Engineer, Department of Water Works, Hammond, Ind., is now with Besozzi & Jozens, Consulting Engineers, Hammond, Ind.

J. P. BARDIN, who was Technical Director, Stalin Metallurgical Plant, Stalinsk, West Siberia, U.S.S.R. (Russia), is now Member, Academy of Sciences of the U.S.S.R., Moscow, U.S.S.R. (Russia).

W. E. ROSENGARTEN, Township Engineer, Lower Merion Township, Ardmore, Pa., was recently presented with the meritorious service gold medal of the Metropolitan Philadelphia Chapter of the American Public Works Assn. at their recent annual dinner.

A. P. MCDONALD is now President of Agate Sewer Pipe Co., Louisville, Ky., successor to P. Bannon Pipe Co., Inc., Louisville, Ky.

W. S. ERNST, formerly Chief Chemist, Cumberland Portland Cement Co., Cowan, Tenn., is now General Plant Superintendent, and Technical Expert, Puerto Rico Cement Corp., Santurce, Puerto Rico.

ROBERT COWEN is now Vice-President and Plant Manager, Roxalin Flexible Lacquer Co., Elizabeth, N. J. He was formerly Technical Director and Production Manager, Flood and Conklin Manufacturing Co., Newark, N. J.

T. G. MOONEY, who was Manager, Technical Service Department, North American Cement Corp., New York City, is now General Manager, Pozzorite Corp., New York City.

WILHELM KRUMBHAAR is Vice-President, in Charge of Technical Development, Reichhold Chemicals, Inc., Brooklyn, N. Y. He was formerly Research Chemist, Beck, Koller & Co., Inc., Detroit, Mich.

G. H. WOODROFFE, formerly Metallurgical Engineer, Reading Iron Co., is now connected with the Baldwin Locomotive Works, Philadelphia, Pa.

R. R. LITEHISER, now Director of Engineering, New York State Crushed Stone Assn., Inc., Albany, N. Y., will return on March 15 to Ohio State Highway Testing Laboratory at Ohio State University, Columbus, Ohio.

P. H. BATES, Chief, Clay and Silicate Products Division, National Bureau of Standards, Washington, D. C., has been awarded the Turner Gold Medal of the American Concrete Institute. Mr. Bates is a past-president of the Institute and is at present chairman of the Publications Committee. The award was made for contributions to science, direction of research and outstanding leadership in advancing the intelligent utilization of cement and concrete.

A separate Department of Mechanics is being set up at Rensselaer Polytechnic Institute. LE ROY W. CLARK, Professor of Mechanics since 1921, will be its director. In connection with the establishment of this department, the Institute plans to expand its materials testing laboratory. Professor Clark has been a member of the R.P.I. faculty since his graduation in 1906.

W. M. WILSON, Research Professor of Structural Engineering, University of Illinois, Urbana, Ill., and Ralph W. Kluge, were awarded the Wason Medal for the most meritorious paper presented in the *Proceedings*, Volume 34, of the American Concrete Institute, The paper was entitled "Tests of Rigid Frame Bridges." T. E. STANTON, JR., Materials and Research Engineer, California Division of Highways, Sacramento, Calif., and Lester C. Meder, received the Wason Medal "For noteworthy research reported to the Institute." This work dealt with resistance of cement to attack by sea water and by alkali soils. These awards were made at the Thirty-fifth Annual Dinner of the A.C.I. held on March 2.

NECROLOGY

We announce with regret the death of 9 members and representatives:

J. S. BRADSHAW, Sales Engineer, Globe Steel Tubes Co., Milwaukee, Wis. Mr. Bradshaw represented his company in its membership on Committee A-1 on Steel and Subcommittee IX on Steel Tubing and Pipe.

JAMES H. DINGLE, City Engineer, Charleston, S. C. Member since 1931.

GRANT K. GILMORE, Manager, Philadelphia District, Pittsburgh Testing Laboratory, Philadelphia, Pa. Member since 1929.

ROBERT H. IRONS, President, Central Iron and Steel Co., Harrisburg, Pa. Mr. Irons held membership on Committee A-1 on Steel and Subcommittees II, III, XI, and XXI as the representative of his company.

JOHN A. MCCULLOCH, Mechanical Engineer, Denver, Colo. Member since 1909.

FRANK P. MEYER, Chief Engineer, Pittsburgh Piping and Equipment Co., Pittsburgh, Pa.

C. A. SELEY, Consulting Engineer, Locomotive Firebox Co., Chicago, Ill. Member since 1936.

VERNON L. SULLIVAN, Manager, El Paso Testing Laboratories, El Paso, Tex. Member since 1928.

ELMER G. WITHERS, President, Elmer G. Withers Architectural Co., Fort Worth, Tex. Member since 1936.

ALBERT SAUVEUR
1863-1939

Dr. Albert Sauveur, who died on January 26, had been a member of the American Section of the I.A.T.M. and subsequently the A.S.T.M., since 1896. Especially in the early years he was active in various phases of committee work. At the 1938 annual meeting in Atlantic City he delivered the Thirteenth Edgar Marburg Lecture on "The Torsion Test." From 1913 to 1915 he was a member of the A.S.T.M. Executive Committee.

For one who is so well known in the materials world it seems somewhat superfluous to give any outline of his activities. Born in Louvain, Belgium, in 1863, he studied at schools in Brussels, Liege, and Massachusetts Institute of Technology, specializing at the latter in mining and metallurgy. After a period of service as chemist at the Pennsylvania Steel Co., in Steelton, and in charge of the Research Laboratories, Illinois Steel Co., in Chicago, and with other steel companies, he became instructor at Harvard. From 1905 to 1924 he was Professor of Metallurgy and until 1935 he was Gordon McKay Professor of Metallurgy and Metallography, becoming Professor Emeritus in 1935.

An outstanding pioneer and renowned throughout the world for his metallurgical developments, particularly in metallography and heat treatment of iron and steel, he has received medals and honors from numerous governments and institutions.

PORTER W. SHIMER
1857-1938

Porter W. Shimer, who did much early pioneering work in the fields of chemical engineering, particularly in its relationship to iron and steel, passed away on December 7, 1938. He had been a member of the Society continuously since 1899. Most of his life was spent in Easton, Pa. He graduated from Lafayette College, Class of 1878. In the fall of 1878, Doctor Shimer became the first chemist of the Thomas Iron Co. and then he became associated with Dr. T. M. Drown. Since 1885, when he established his own chemical and metallurgical laboratories, he had been actively engaged in applications of analytical chemistry to the raw materials and products of metallurgical industries and did much to demonstrate the importance of chemical control.

For several years he was a member of the old International Steel Standards Committee, his fellow workers being Doctor Drown, Dr. C. B. Dudley, A. A. Blair of the firm of Booth, Garrett & Blair, and W. P. Barba of the Midvale Steel Co. He and his son, Edward B. Shimer, did much pioneering work in the case hardening process. He was awarded numerous honors by engineering and technical societies.

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